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SUPPLEMENT TO
PHOTOGRAPHIC INTELLIGENCE CENTER - REPORT 1

[redacted]

UNCLASSIFIED

Japanese ELECTRONICS

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by authority of Lt. 18 May 46 - PIC
by Ray M. Stroupe
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Capt., Inf

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AIR INTELLIGENCE GROUP, DIVISION OF NAVAL INTELLIGENCE
OFFICE OF THE CHIEF OF NAVAL OPERATIONS, NAVY DEPARTMENT

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MARCH 1945

No Porn

PHOTOGRAPHIC INTELLIGENCE REPORT

JAPANESE ELECTRONICS

- RADAR
- RADIO
- DIRECTION FINDING
- NAVIGATIONAL AIDS

UNITED STATES NAVAL PHOTOGRAPHIC INTELLIGENCE CENTER
NAVY YARD, WASHINGTON 25, D.C.

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FOREWORD

Purpose of Report:

1. To compile a pictorial reference on Japanese Electronics installations.

2. To develop Photographic Interpretation techniques for extracting needed information on Electronics from aerial photographs.

3. To present coordinated Electronics information in combination with Photographic Interpretation data in order to supply maximum intelligence on enemy installations.

Additional looseleaf pages will be issued to holders of this report at such times as important new information becomes available.

CHARLES H. COX

Lieutenant Colonel, USMCR

Officer-in-Charge

Photographic Intelligence Center

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ACKNOWLEDGMENT . . .

is made to all of the many military activities from whom advice, criticism and published material has been sought in the process of writing this report, and in particular to the personnel of the NAVAL RESEARCH LABORATORY who have contributed freely of their time and invaluable information.

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INTRODUCTION

JAPANESE ELECTRONICS

Prepared November 1944, replaces "Japanese Radio-Radar and Related installations" (P.I.C. No. 2 - 5/6/8/9/-K-1/44) and is a revised and enlarged edition of the latter. (Certain examples of German Electronics are included because of German equipment and technicians available for Japanese use.)

For further and detailed information on Japanese electronics equipment see Naval Research Laboratory Report #RA3A215B entitled: "Technical Data on Japanese Radio and Radar Equipment."

This report deals mainly with four distinct types of electronics installations. The interpreter should clearly understand the exact functions of each.

RADAR
(Radio Detecting and Ranging)

1. Transmits and receives.
2. Provides early warning of approaching aircraft and surface vessels.
3. Used in connection with gunfire to give accuracy of range and deflection (called "Fire Control" type).
4. May be used for Navigational purposes.

COMMUNICATIONS
("Radio")

1. Transmits and receives spoken word or code.

DIRECTION FINDERS
(Receives Radio Signals)

1. Detects radio and records range and direction.
2. Aid to Navigation - It is believed this is a primary use of Japanese installations.

NAVIGATIONAL AIDS
(Navigational Beam)

1. Transmits radio signals creating a "beam" for guiding ships and planes to home base or to bombing target.

Tendencies towards standardization are an inevitable outgrowth of development, especially in the electronics field. Because of this, the interpreter's job with respect to newly covered installations becomes easier in direct proportion to his familiarity with the old or captured installations.

It is with this purpose in mind that a large number of photographic examples of known installations are included and an attempt made to group them in a logical manner, reflecting their use in waging war.

Frequencies are given in connection with all installations, to enable the interpreter to check his visual interpretation against frequency data obtained from radio signals picked up from any particular area.

[redacted]

SCALE

In order to establish a more realistic yardstick of the possibilities of electronics interpretation, the following table of photographic scales is prepared.

The first column represents the smallest scale at which the object may usually be recognized.

The second column suggests a scale at which a good detailed interpretation can usually be made.

It is assumed that good quality prints are available and that the interpreter knows what he is looking for.

RADAR	RECOGNITION	DETAIL
Fixed types	1/10000	1/5000
Mobile types	1/8000	1/5000
Fire Control	1/5000	1/2000
COMMUNICATIONS		
Lattice masts	1/15000	1/8000
Stick masts	1/10000	1/5000
DIRECTION FINDERS		
Open Adcock	1/18000	1/11000
Housed Adcock	1/15000	1/10000
Portable or unusual types	1/8000	1/5000

NAVIGATIONAL AIDS
Vary considerably in size and type.

FREQUENCIES

RADAR . . . . . VHF, UHF, SHF (30-30000 Mcs.)
COMMUNICATIONS . . . . . VLF, LF, MF, HF, VHF (0.01-30 Mcs.)
DIRECTION FINDERS . . . . . MF, HF (0.3-30 Mcs.)
NAVIGATIONAL AIDS . . . . . LF, MF, HF, VHF (0.03-300 Mcs.)

In general: low frequencies indicate long ranges; high frequencies indicate short ranges. This is true of all types of electronics shown.

STANDARD FREQUENCY TABLE

SHF -- Super High Frequency . . . . 3000-30000 Mcs. ("microwave")
UHF -- Ultra High Frequency . . . . . 300-3000 Mcs.
VHF -- Very High Frequency . . . . . 30-300 Mcs.
HF -- High Frequency . . . . . 3-30 Mcs.
MF -- Medium Frequency . . . . . 300-3000 Kcs. (0.3-3 Mcs.)
LF -- Low Frequency . . . . . 30-300 Kcs. (0.03-0.3 Mcs.)
VLF -- Very Low Frequency . . . . . 10-30 Kcs. (0.01-0.03 Mcs.)
D.F. -- . . . . . Direction Finder.

SECTION-I

1.01 — 1.99

RADAR

In an effort to eliminate confusion with respect to Japanese Radar Designations, the following table is included. In cases where popular names have developed, the popular name is used for page headings.

JAPANESE RADAR DESIGNATIONS

POPULAR NAME	JAPANESE TEMPORARY DESIGNATION	JAPANESE ABBREVIATED DESIGNATION
"Guadalcanal" type	Mark 1, Model 1	Mark 11
"Attu" type	Mark 1, Model 1, Modification 1	Mark 11
"Mobile Mattress"	Mark 1, Model 2	Mark 12
"Mark 6 Portable"	Air Mark 6 "Special"	?
"Mark 13 Portable"	Mark 1, Model 3	Mark 13
"Wewak Yagi"	"YA"	Mark 8 ?
"Chi"	"Chi"	Mark 229
"Ship Mattress"	Mark 2, Model 1	?
Ship "2-Horn" type	Mark 2, Model 2	Mark 51
Ship "3-Horn" type	Mark 2, Model 2 Modification 2	Mark 61
"Parabaloid"	Mark 2, Model 3	Mark 52
_____	Air Mark 6, Model 4	Mark 6
_____	Mark 4, Model 1	Mark 21
_____	Mark 4, Model 2	Mark 21
_____	Mark 4, Model 3	Mark 42?
_____	Mark "TA", Model 1	?
_____	Mark "TA", Model 2	?
_____	Mark "TA", Model 3	?

RADAR
SUMMARY

In principle, all Radar systems are alike, although individual installations may vary widely in physical aspects as well as tactical use. Examples of land based, airborne, and ship mount radar are shown and discussed in this section.

Simply stated Radar is an electronic device which emits continuous stream of radio waves of extremely high frequencies (70 to 30,000 Mcs.) which, when reflected back from a dense obstruction in their path, are received and presented on a cathode ray tube to record position and range of that obstruction in a visual manner.

Each installation both transmits and receives.

Radar will not penetrate land forms, buildings, ships and planes, and, therefore records them by reflection. Generally, Radar will penetrate clouds and foliage, however, rain-laden dense cumulus clouds may be picked up, as may be dense forest.

Radar waves travel in a straight line except for atmospheric refraction which bends the beam earthwards, and which is important beyond the 20 mile range. Very little is known as yet concerning the exact effects of refraction (called "propagation"). However, it is considered reasonable, in order to plot radar waves as a straight line, to regard the earth as being 4/3 of its actual diameter when calculating the effect of curvature of the earth on radar "shadows" under "standard" weather conditions.

LAND BASED SEARCH RADAR

The Japanese often locate search Radar on high points in mountainous areas, and on a high concrete base in low flat areas. This enables the radar to search greater ranges close to the earth's surface. Radar sites are very often near the seacoast.

When two Radars are used in close proximity it is likely to be for the following reasons:

1. One may search while the other tracks objective.
2. Two may be required to complete coverage of all required sectors of search.
3. The additional set may be erected as a supplementary installation in the event of damage or malfunctioning of the first set.

It is important that interpreters learn to associate the graphic appearance and sizes of Radar types with their known frequency band, for as information on signals received is usually available, it is possible to make a positive and exact identification in this way.

INTERPRETATION FEATURES

1. Size and shape of screen.
2. Blast wall sometimes present (example: Kiska).
3. Often mounted on high concrete base, particularly low coral islands (example: Makin).
4. Generator building often visible (example: Marcus).
5. May be found as twin installation (example: Kiska).
6. Site will be free from dense obstructions in area of required coverage.

REPORTING ON SEARCH RADAR

In Photographic Interpretation reports on radar installations, the following information is desirable :

1. Exact location and elevation above sea level.
2. Probable area of search (nearby obstructions etc.).
3. Height of screen above ground.
4. Generator Building location - if visible.
5. Size and shape of screen (note particularly if parabolic or horn.)
6. Operation of screen.
   (a) fixed
   (b) rotates
   (c) elevates
   (d) tips upward
7. Design of base for screen.
8. Probable use of installation.
9. Type of radar - if known.
10. Frequency, Pulse Length, Pulse Frequency.

RANGE

Ranges of Radar equipment cannot be cited in exact figures due to variations caused by weather conditions, size of objective, radar operators skill etc. However, rough ranges are given in connection with each type in the following pages.

The concern of the Japanese with respect to Radar and its development and use is expressed in the following excerpt from a captured Japanese notebook, probably written from a class lecture early in 1944.

"The value of radar (in firing action) is tremendous. We must quickly marshall its full capabilities since it is the very essence of the present war of science. Great advantages can be gained by progress in radar. Those responsible for meeting the present war situation in its tactical phases must examine the essential elements and endeavor to obtain maximum efficiency in both men and equipment in the Imperial Navy. A glance at the present condition of the fleet reveals that the ships of those with an active interest (TN: in radar) are well-equipped in all essential details and the accuracy of some of the equipment has exceeded all expectations. On the other hand there are many who lack confidence in its use and feel that radar is a white elephant on their hands. We must strive all the more for the perfection of radar by further research and training."

RADAR
SUMMARY (CONT.)

TABLE OF IMPORTANT JAPANESE RADAR TYPES

	POPULAR NAME	JAPANESE DESIGNATION	ANTENNA	FREQUENCY IN MCS.	P.R.F. IN CPS.	PULSE LENGTH IN MICROSECONDS	MAXIMUM RANGE IN NAUTICAL MILES						USE	REMARKS	PAGE NO.
							A/C Form	A/C Single	BB CA	CL	DD	SS			
LAND-BASED SEARCH	GUADALCANAL TYPE	MARK I, MODEL I	26'x18'	97-103	880-1200	12-30	75	35-45	13	10	8	--	A.W.	FIRST FOUND ON GUADALCANAL	1.05
	"ATTU TYPE"	MARK I, MODEL I MODIFICATION I	28'x14'x2 1/3'	97-103	880-1200	12-30	75	35-45	13	10	8	--	A.W.	'BOX' TYPE ANTENNA	1.10
	"MOBILE MATTRESS"	MARK I, MODEL 2	14'x7'x1 2/3'	187-205	800-1500	3½-12	100	75	--	--	--	--	A.W.	OFTEN FOUND EMPLACED IN A REVETMENT	1.14
	"MARK VI PORTABLE"	AIR MARK VI "SPECIAL"	7' YAGI DIPOLES MOUNTED ON COLLAPSIBLE TRIPOD	140-160	1000	3-5	75?	--	--	--	--	--	A.W.	PORTABLE ADAPTATION OF AIR-BORNE SET	1.16
	"MARK 13 PORTABLE"	MARK I, MODEL 3	VARIOUS-USING ARRAYS OF 7' YAGI DIPOLES	140-160	500	10	45	--	--	--	--	--	A.W.	MAY BE IMPROVED AIR MARK VI WITH HIGHER POWER. SET IS PORTABLE.	1.16
	"WEWAK TYPE"		2 HORIZONTAL ROWS OF (YAGI?) DIPOLES ON A MAST	60-80	750	25-35	125	90	--	--	--	--	A.W.	TRANSPORTABLE PHOTOGRAPHED AT WEEWAK 1943. INCREASING USE.	1.17
	"CHI"	"CHI" OR MARK 229	SIMILAR TO WEWAK TYPE"	60-80	500 OR 1000	25-35	125	90	--	--	--	--	A.W.	FIXED TRANSMITTER T. AND R. ARE AT SEPARATE LOCATIONS. INCREASING USE.	1.17
SHIP-BORNE	" SHIP MATTRESS"	MARK 2, MODEL I	14'x7'x1 2/3' (SIMILAR TO MOBILE MATTRESS)	187-205	1000	10	100	75	20	15	12	--	A.W. S.W.	SAME AS MOBILE MATTRESS WITH A DIFFERENT ANTENNA MOUNT.	1.18
	"2-HORN TYPE"	MARK 2, MODEL 2	2 ELECTRO-MAGNETIC HORNS APPROX. 3' LONG	3000	2500	6	--	--	25	18	12	8	S.W.	HORNS MAY BE IN TURNTABLE. RECEIVER IS HIGHER THAN TRANSMITTER.	1.18
	"3-HORN TYPE"	MARK 2, MODEL 2 MODIFICATION 2	3 ELECTRO-MAGNETIC HORNS APPROX. 3' LONG	3000	2500	6	--	--	25	18	12	8	S.F.C. S.W.	RECEIVER HORN IS REPLACED BY DOUBLE HORN ATTACHMENT	1.18
	" PARABALOID"	MARK 2, MODEL 3	PROBABLY PARABALOID	520	---	30	--	25	15	--	--	--	S.W. A.W. F.C.A?	FOR SMALL CRAFT. PROBABLY ADAPTATION OF GERMAN WURZBURG. (CAPTURED DOCUMENTS ONLY)	--
AIR-BORNE		AIR MARK VI MODEL 4	VARIOUS: YAGI, DIPOLES, ARRAYS	140-160	1000	3-5	15	10	25	18	12	--	A.S.V. A.I.	FIRST USED IN BETTY. NOW IN ALL TYPES OF PLANES WITH VARIOUS ANTENNA DESIGNS	1.20
FIRE AND SEARCHLIGHT CONTROL							ACCURACY RANGE	ACCURACY BEARING	ACCURACY ELEVATION						
		MARK IV, MODEL I (S-3)	MATTRESS 25 3/4'x6'x4'	200	2000	3-5	50 YDS	0.5°	0.5°				A.A.F.C. A.W.	ADAPTATION OF OUR SCR 268	1.25
		MARK IV, MODEL 2 (ALSO MODIF. 2)	PROBABLY MATTRESS	200	1000	3	50 YDS	0.5°	0.5°				A.A.F.C. A.W.	SMALLER AND IMPROVED MK IV, MODEL I FOR MASS PRODUCTION (CAPTURED DOCUMENTS ONLY)	1.25
		MARK IV, MODEL 3	4 YAGIS ON S/L I YAGI ON S/L CONTROLLER	200	2000	3-5	100 YDS	1°	1°				A.A.F.C. S.L.C.	SIMILAR TO BRITISH "SLC" BUT TRANSMITTING ANTENNA SEPARATED	1.22
		MARK "TA", MODEL I	4 YAGIS WITH TRANS. ANTENNA ATTACHED ABOVE	200	---	3	--	--	--				A.A.F.C.	(CAPTURED DOCUMENTS ONLY)	1.23
		MARK "TA", MODEL 2	5 YAGIS - EACH WITH REFLECTOR	200	1000	2	100 YDS	--	--				A.A.F.C. A.W.	(CAPTURED DOCUMENTS ONLY)	1.23
		MARK "TA", MODEL 3	ELABORATE ANTENNAE SYSTEM T/R SEPARATED	75?	1000-2000	1-2	25 YDS	0.5°	1°				A.A.F.C.	ADAPTATION OF BRITISH "GL" MARK 2 (CAPTURED DOCUMENTS ONLY)	1.24

P.R.F. - PULSE REPETITION FREQUENCY
C.P.S. - CYCLES PER SECOND

A.W. --- AIR WARNING
S.W. --- SURFACE WARNING
S.F.C. - SURFACE FIRE CONTROL

A.A.F.C.-A/A FIRE CONTROL
S.L.C. - SEARCHLIGHT CONTROL
A.S.V. - AIRPLANE SEARCH FOR SURFACE CRAFT
A.I. --- AIRBORNE INTERCEPT

NOTE: IN ADDITION TO THE ABOVE, GERMAN RADAR TYPES MAY BE FOUND IN USE IN JAPANESE CONTROLLED AREAS.

[redacted]

RADAR
SUMMARY

The following diagrams were prepared by the Special Devices Division of the Bureau of Aeronautics, Navy Department, for use in connection with terrain models and special R.P.D. equipment.

They are included here because they constitute a rapid way of estimating enemy radar coverage, with or without the use of terrain models.

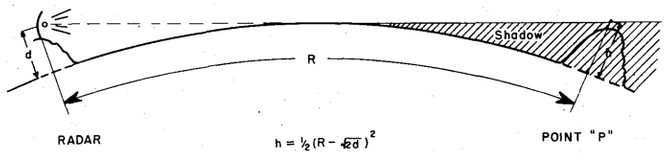
Charts, prepared by Gen. Hq., S.W.P.A., are available for plotting Japanese Radar coverage and propagation according to type of Radar and number of A/C in formation.

Curvature can be neglected within 20 miles of the radar site, and outside of that range relatively few curvature computations are required. These computations fall into two simple classes:

CASE I: OPEN SEA BETWEEN RADAR AND OBJECT. In this case no shadow will be present on the flat model. Referring to diagram, if "h" is greater than the height above sea level of the terrain at "P", no ground echo will appear on the radar.

EARTH CURVATURE

Case 1: Open Sea Between Radar and Object

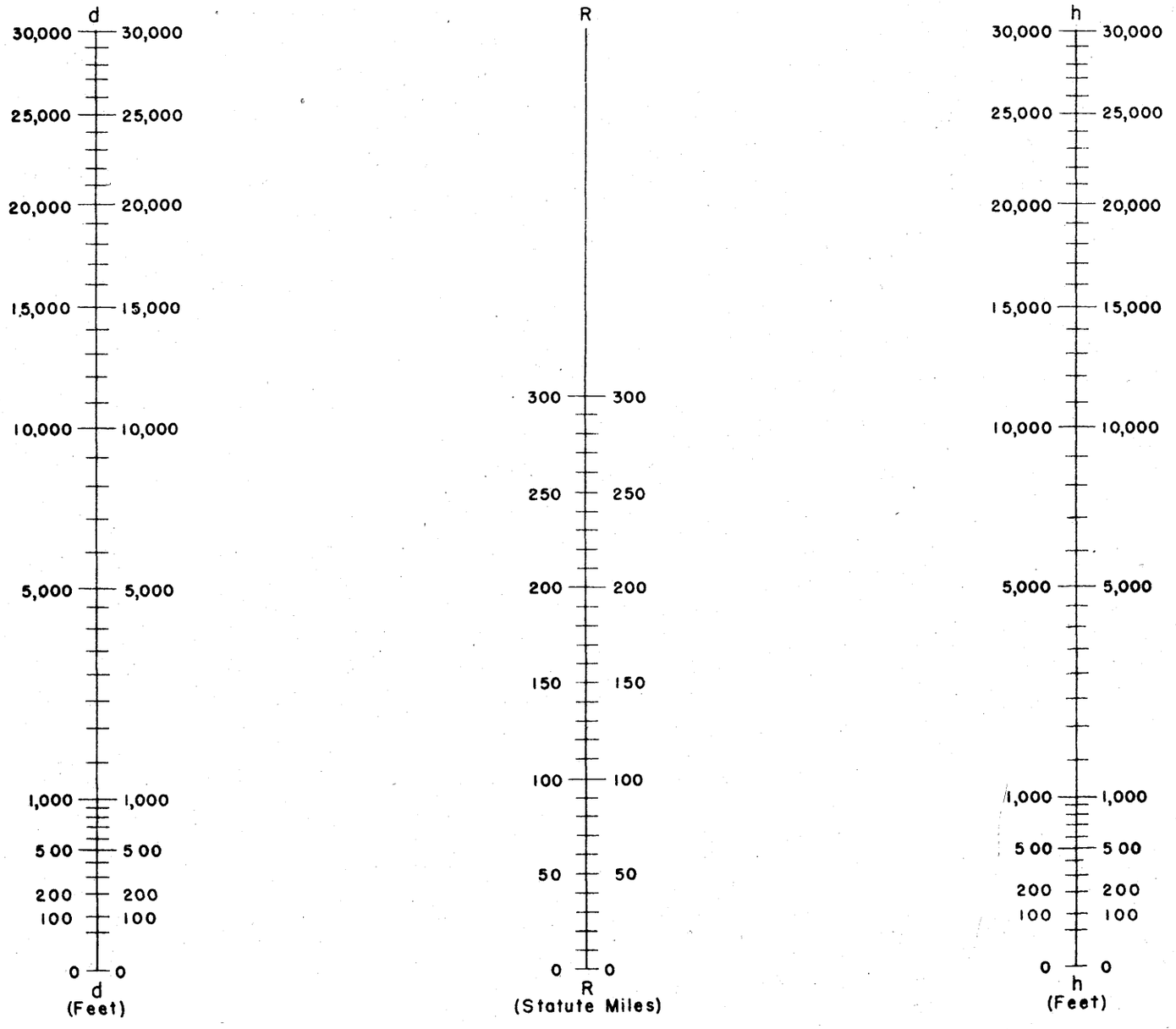


d = HEIGHT OF RADAR ABOVE SEA-LEVEL
R = RANGE OF "P" FROM RADAR
h = HEIGHT OF SHADOW AT "P" DUE TO CURVATURE

HOW TO USE NOMOGRAPH

Pass a ruler through the points on the two vertical lines representing known quantities, and read off the solution at the intersection of the third line with the ruler.

d = HEIGHT OF RADAR ABOVE SEA-LEVEL
R = RANGE OF "P" FROM RADAR
h = HEIGHT OF SHADOW AT "P" DUE TO CURVATURE



Example: If the radar is at 1250 feet, the shadow height at 200 miles is found by lining up the ruler with "d" = 1250 and "R" = 200. The ruler will then pass through "h" = 11,250 feet, which is the solution.

RADAR

SUMMARY

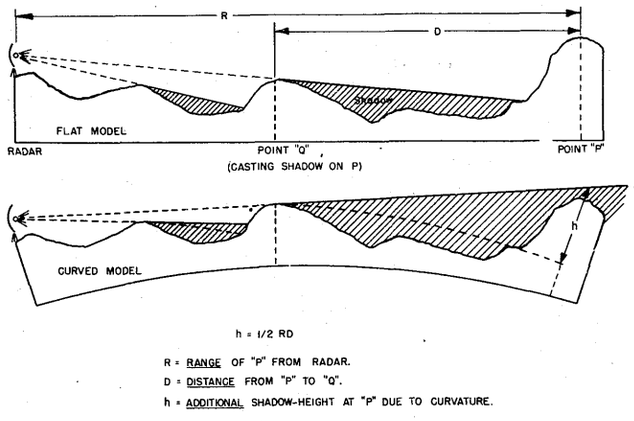
CASE 2: SHADOW CAST BY A TERRAIN FEATURE IN THE FOREGROUND. In this case the shadow edge at a point "P" will be raised by earth curvature by an amount which depends on the range of "P" and the distance between "P" and the feature which casts the shadow. Referring to page 42, if the amount which the mountain at "P" protrudes above the shadow edge on the flat model is less than the computed "h", the effect of curvature will be to remove the mountain from the beam.

Whenever a hill is found to disappear into shadow as a result of curvature computations, a shadow cannot be cast by this hill on objects still more distant. Should such a problem arise, elevate the hill with a pencil or any convenient object to the computed shadow edge, and use the new shadow (cast on the more distant object by the pencil) as the basis for making a case 2 computation.

Note: In rare cases, it may be difficult to decide whether case 1 or case 2 applies. In such circumstances apply both, and take the higher of the two computed shadows.

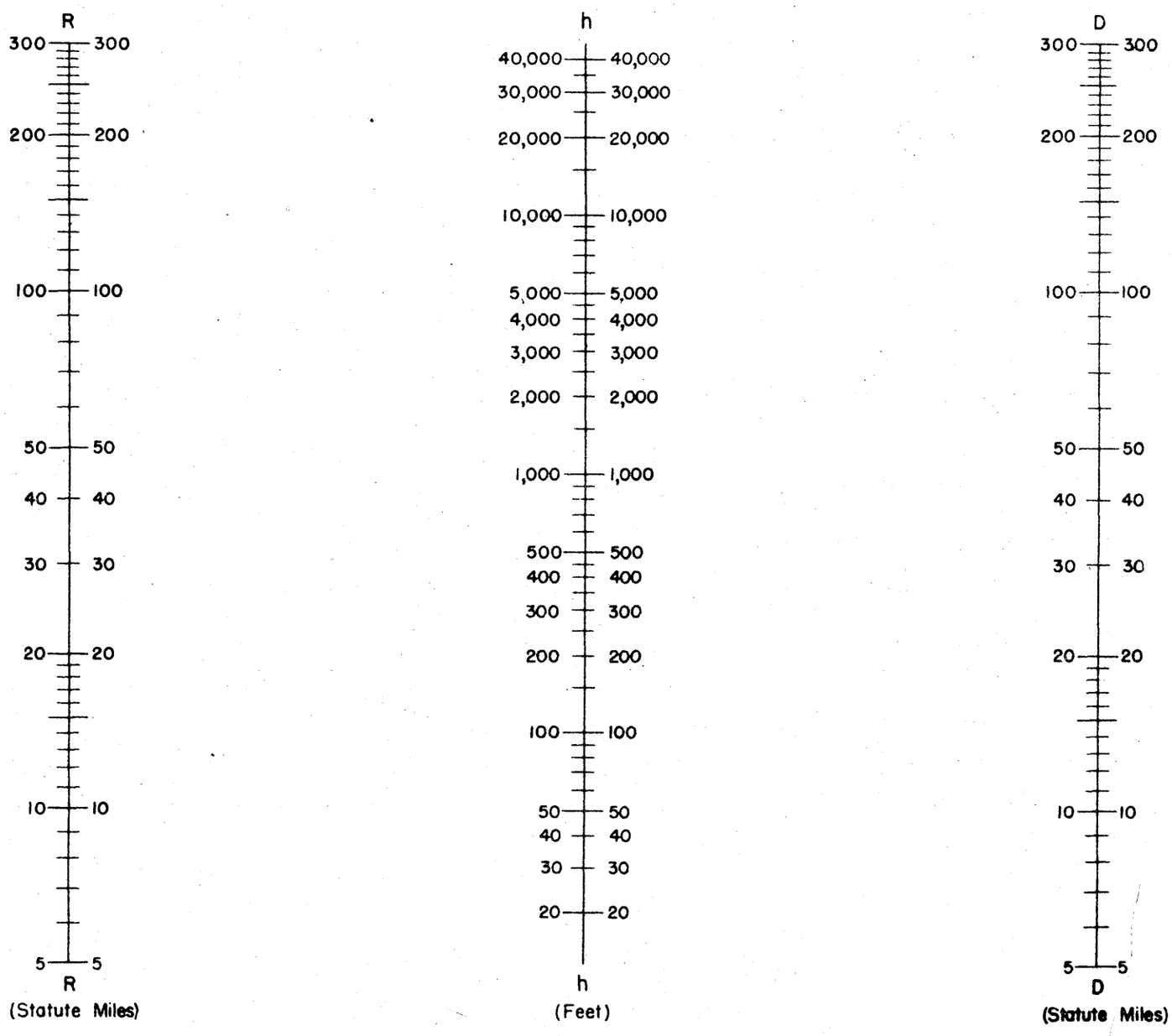
EARTH CURVATURE

Case 2: Shadow Cast By Terrain Feature in Foreground.



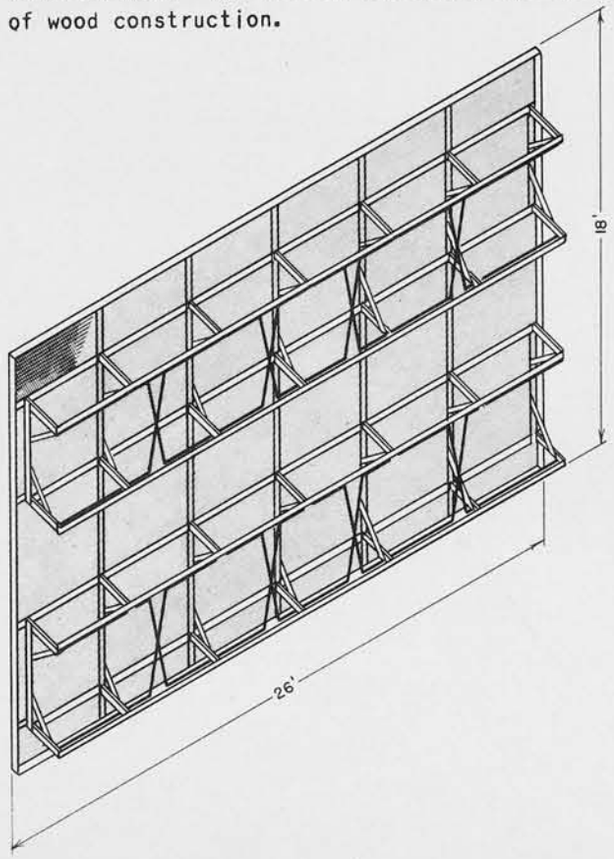
h = 1/2 RD

R = RANGE OF "P" FROM RADAR.
D = DISTANCE FROM "P" TO "Q".
h = ADDITIONAL SHADOW-HEIGHT AT "P" DUE TO CURVATURE.



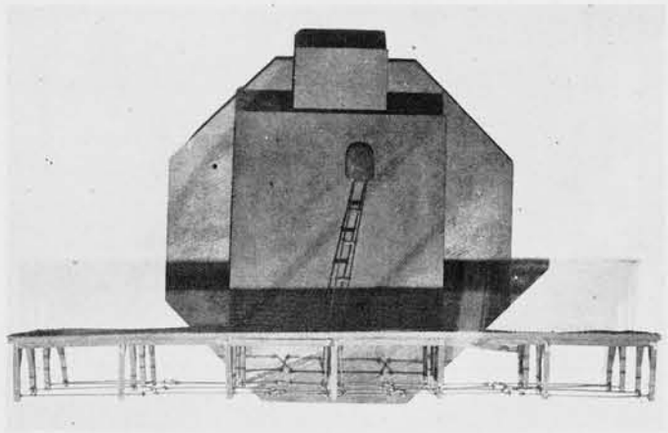
Example: Suppose the distant point "P" is at a range of 200 miles, and the object casting a shadow on "P" is at a distance of 150 miles from "P". Passing the ruler through "R" = 200 and "D" = 150, the answer "h" = 15,000 feet will appear at the intersection of the ruler and the center scale.

The first captured Japanese Radar, found on Guadalcanal, is shown on this page.
The antenna is five "elements" (half-wave dipoles) wide. Each section is 2 dipoles high. Polarization is horizontal (i.e. The dipoles lie horizontally rather than vertically). The screen is backed with chicken wire type mesh. This equipment has a frequency of 96.5 to 103 Mcs. It is primarily for early warning of aircraft approach and gives range and bearing with a maximum range of 50 to 60 miles for high-flying aircraft. The antenna rotates with the shack to which it is attached but does not elevate. The shack is motor-driven. The screen framework and shack are of wood construction.

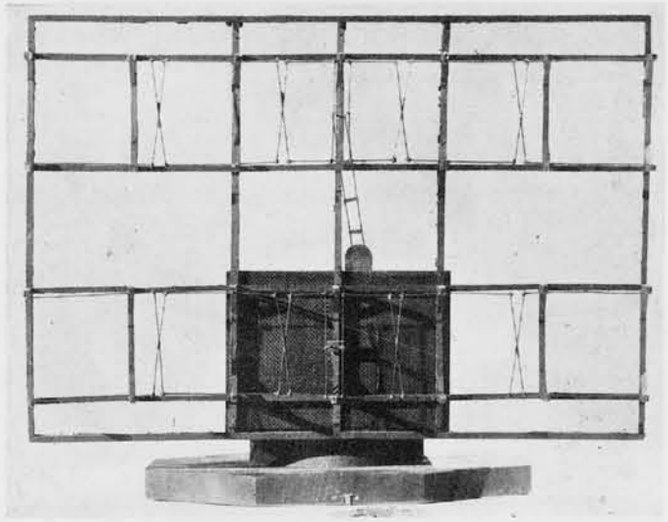


Drawing of Guadalcanal type screen with steel framework, which typifies all later models.

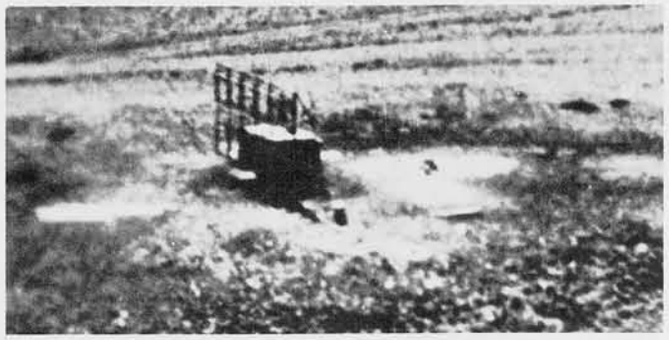
LOCATION	GUADALCANAL
TYPE (MARK I, MODEL I)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. 880 - 1200 PULSE	12 - 30
MAXIMUM RANGE	60 N. MI.



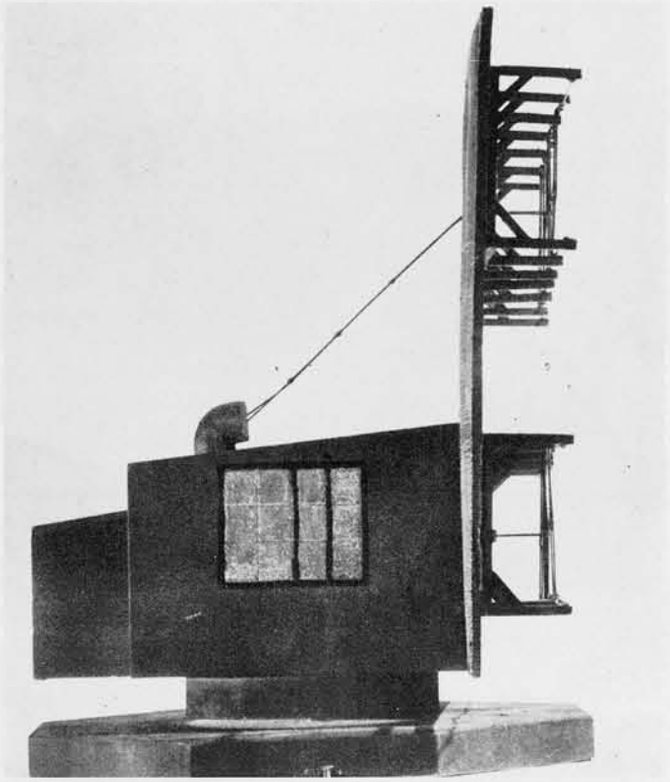
GUADALCANAL, SOLOMONS
ABOVE: Plan view of a scale model. Note small appendage at rear of control shack which is characteristic of Guadalcanal and Attu type radars.



GUADALCANAL, SOLOMONS
ABOVE, front view of scale model showing details of the antenna.



GUADALCANAL, SOLOMONS



GUADALCANAL, SOLOMONS
ABOVE: Side view of scale model showing shed roof which is characteristic of all Guadalcanal types. The screen framework here is of wood. Later models incorporated the use of steel for structural framework.
BELOW: Low obliques taken at Guadalcanal.

GUADALCANAL, SOLOMONS

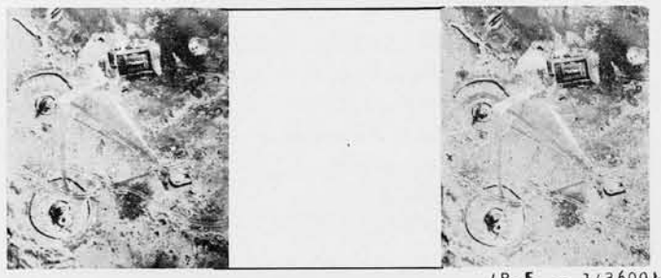
CONFIDENTIAL

RADAR

GUAD. TYPE (CONT.)

KISKA, ALEUTIANS (R.F. - 1 1200)

ABOVE: note strong screen shadows. Generator building not present, power coming from a removed source. Revetment 1 foot high and 32 feet in diameter. Distance between screens is 130 feet.



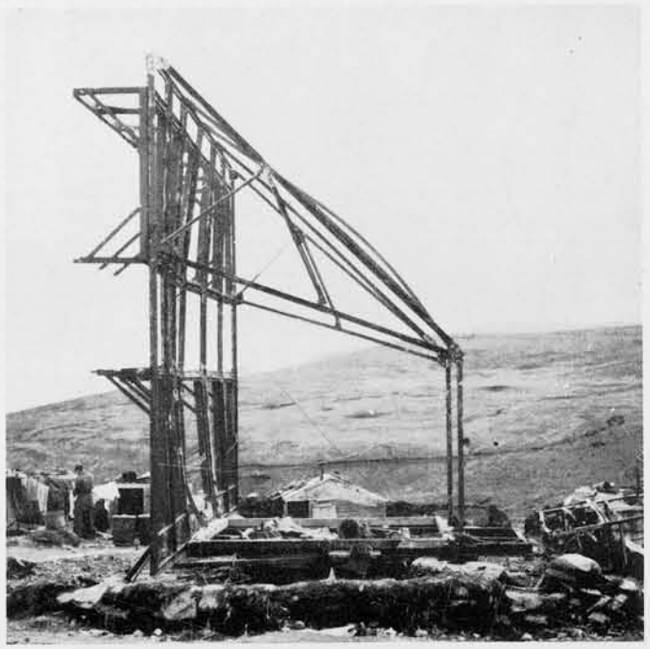
KISKA, ALEUTIANS (R.F. - 1/3600)

The Guadalcanal type radar is now constructed as shown on this page, with a metal screen framework.

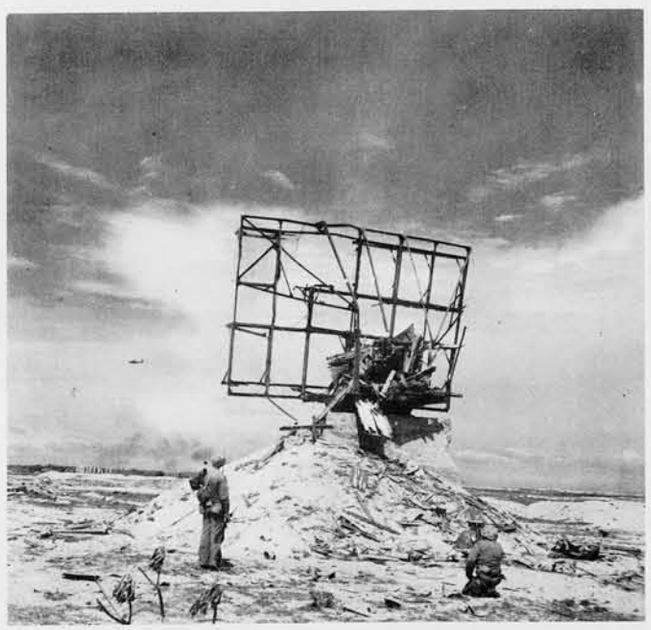
Both localities afford examples of twin installations, where one set may be used for search while the other tracks a specific target.

Screen is 28 feet wide and 18 feet high. Control shack, which rotates with screen, is 10' x 10' with an additional small square projection on side opposite screen.

LOCATION	KISKA
TYPE . . . . (MARK 1, MODEL 1)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. 880-1200	PULSE . . 12-30
MAXIMUM RANGE	75 N. MI.

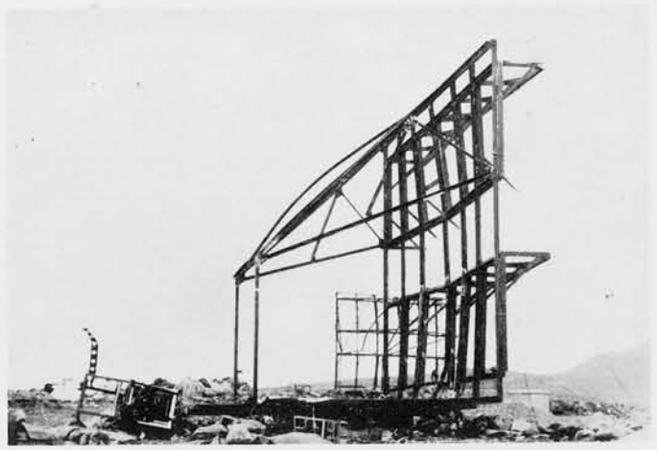


KISKA, ALEUTIANS

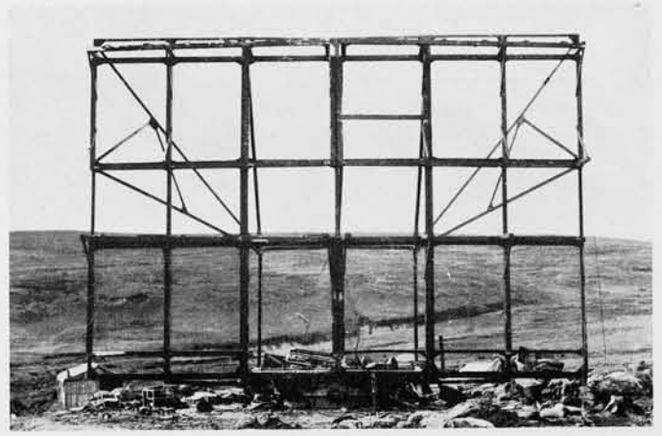


KWAJALEIN, MARSHALLS

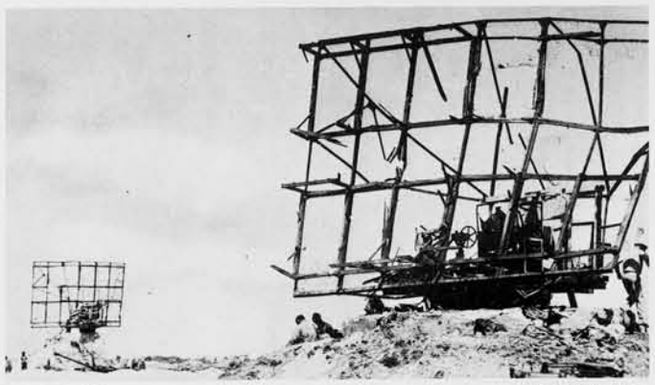
ABOVE: note elevated emplacement used on low coral island. This is the same type of radar as seen at Kiska.



KISKA, ALEUTIANS



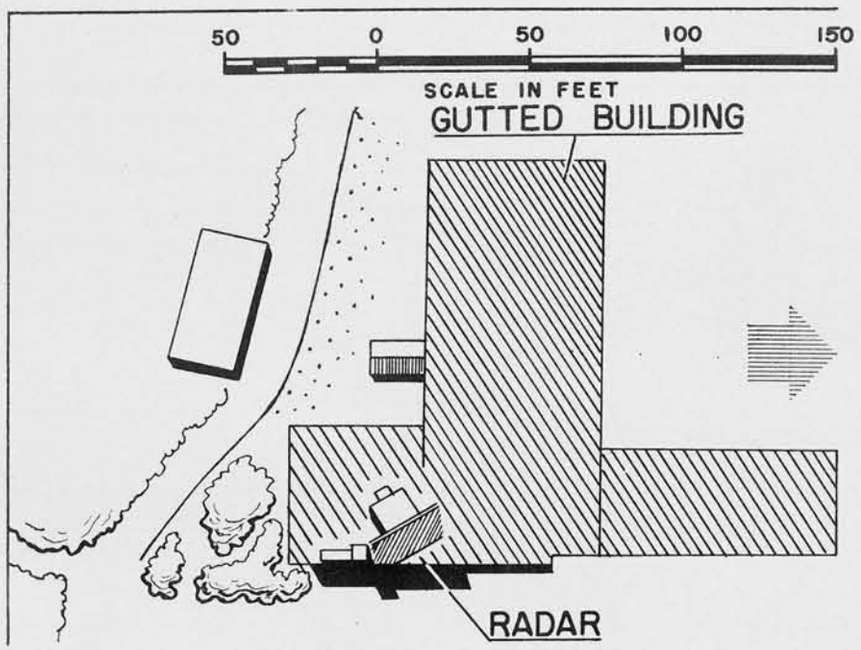
KISKA, ALEUTIANS



LOCATION	KWAJALEIN
TYPE . . . . (MARK 1, MODEL 1)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. . . . . 880 - 1200	PULSE . . 12 - 30
MAXIMUM RANGE	75 N. MI.

RADAR

GUAD. TYPE (CONT.)

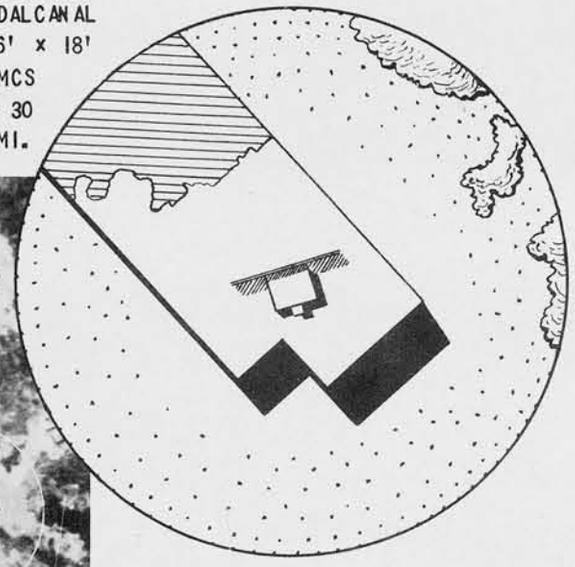


LOCATION . . . . . PEALE I., WAKE
TYPE . . . . . (MARK I, MODEL I) . . . . . GUADALCANAL
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . . . PULSE . . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

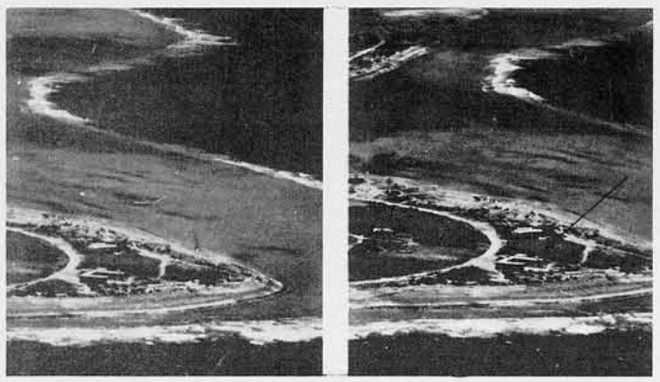
(NO PARALLAX)

PEALE ISLAND, WAKE

HEEL POINT, WAKE



LOCATION . . . . . WOTJE
TYPE . . . . . (MARK I, MODEL I) "GUADALCANAL"
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . . . PULSE . . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

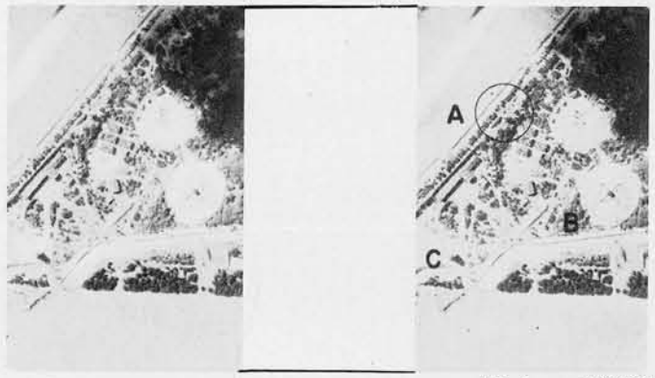


LOCATION . . . . . HEEL PT., WAKE
TYPE . . . . . (MARK I, MODEL I) "GUADALCANAL"
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . . . PULSE . . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

On this page are shown three more localities having Guadalcanal type Radar, similar to those at Kiska and Kwajalein. On coral islands the required height for installation is sometimes obtained by mounting set atop existing buildings. Note particularly the small square appendage on back of control shack.

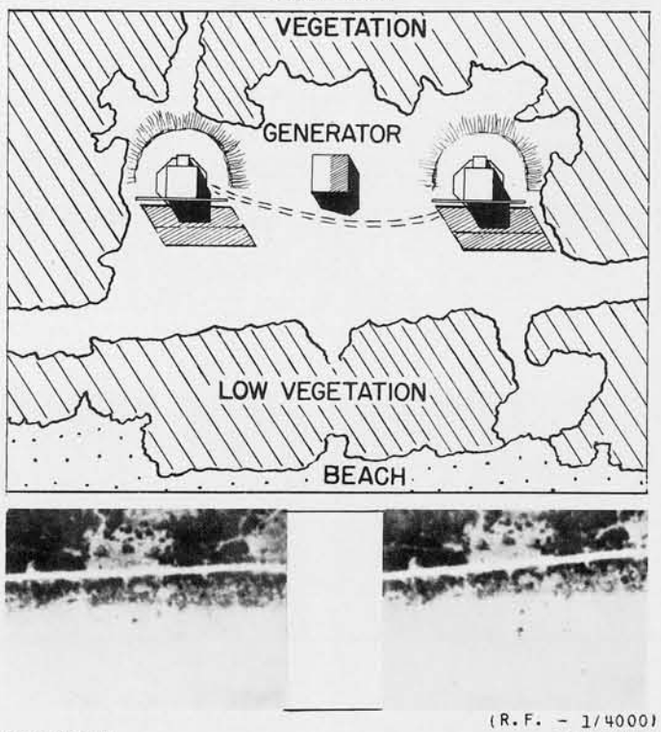
CONFIDENTIAL

RADAR
GUAD. TYPE (CONT.)



(R.F. - 1/9000)

MARCUS

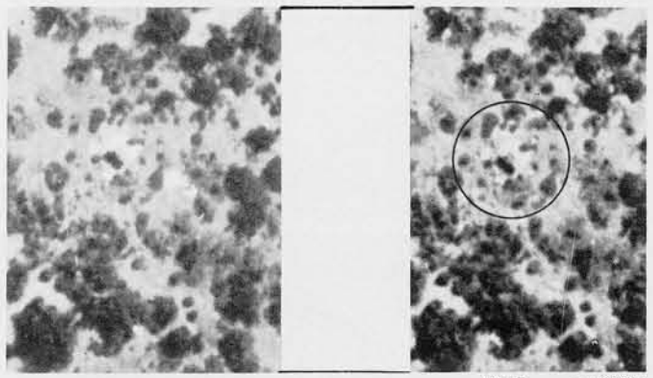


(R.F. - 1/4000)

LOCATION . . . . . MARCUS
TYPE . . . . . (MARK I, MODEL I) . . . . . "GUADALCANAL"
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . PULSE . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

The above twin Radar installation at Marcus is located near the D. F. Station. The generator building is centrally located and is approximately 12 feet square.

In this case, one Radar may be used for search while the other tracks.



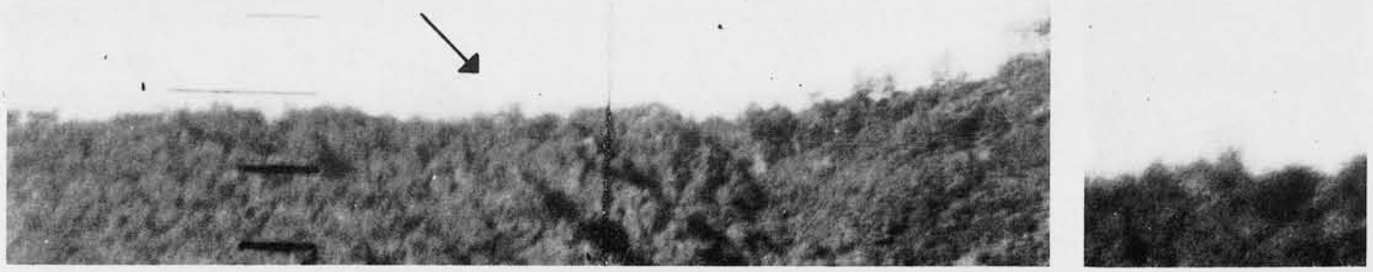
(R.F. - 1/3000)

LOCATION . . . . . NAURU
TYPE . . . . . (MARK I, MODEL I) . . . . . "GUADALCANAL"
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . PULSE . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

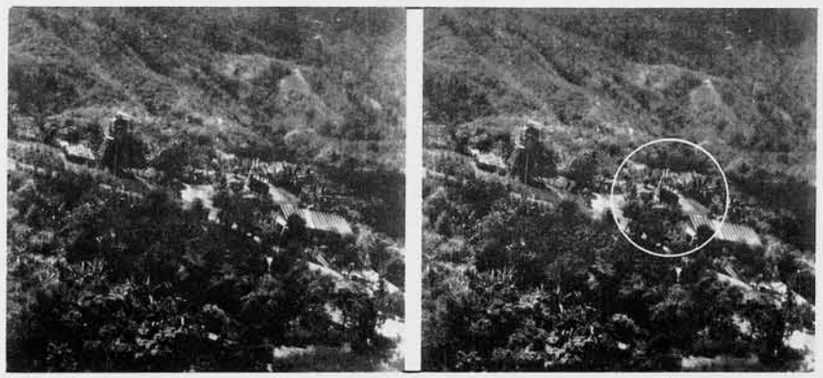
This installation at Nauru was once thought to have had a parabolic screen. However, it is now believed that the equipment functions in a similar manner and at the same frequency as the "Guadalcanal" type.

Previously, this set was shown as an example of a separate type of Japanese Radar, called "Nauru type". However in light of present information it seems more fitting to include it under Guadalcanal type.

This submarine photo of Shikoku, Japan, shows the faint outlines of a screen which is probably the Guadalcanal type radar. Identification cannot usually be based on such meager information, however. (Below)



SHIKOKU, JAPAN



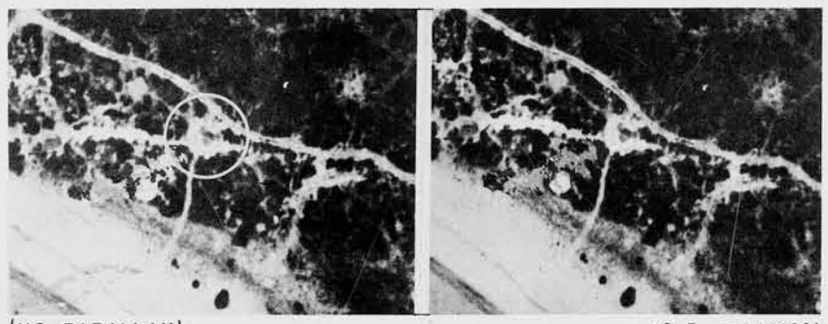
LOCATION . . . . . RABAUL
TYPE . . . . . (MARK I, MODEL I) . . . . . "GUADALCANAL"
ANTENNA . . . . . 26' x 18'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . PULSE . . . . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

At the present date it is more likely that the Mobile Mattress, Attu, and other new types will be found in greater numbers than the Guadalcanal type.

The Stereo oblique to the left is a remarkably clear example of the "Guadalcanal" type. Note the projection of rows of dipoles from the front of the screen, which is two-dimensional and does not have a box-like character such as may be observed in "Attu" type shown on other pages later in this section. The flat roof on the control shack is characteristic of the Guadalcanal type. Note also that clearing of surrounding vegetation is not necessary for operation of this Radar.

RADAR
GUAD. TYPE (CONT.)

The Kuku Point Radar is apparently a slightly different version of the Guadalcanal type. The bend as shown in the artist's drawing is approximately 25 degrees from a straight line. The low revetment suggests Kiska installations but is much smaller in diameter.



(NO PARALLAX) (R.F. - 1/2800)

LOCATION	KUKU PT., WAKE
TYPE (MARK I, MODEL I)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. 880 - 1200 PULSE	12 - 30
MAXIMUM RANGE	75 N. MI.

LOCATION	MALOELAP
TYPE (MARK I, MODEL I)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. 880 - 1200 PULSE	12 - 30
MAXIMUM RANGE	75 N. MI.

(R.F. - 1/5000)

LOCATION	MALOELAP
TYPE (MARK I, MODEL I)	"GUADALCANAL"
ANTENNA	26' x 18'
FREQUENCY	100 MCS
P.R.F. 880 - 1200 PULSE	12 - 30
MAXIMUM RANGE	75 N. MI.

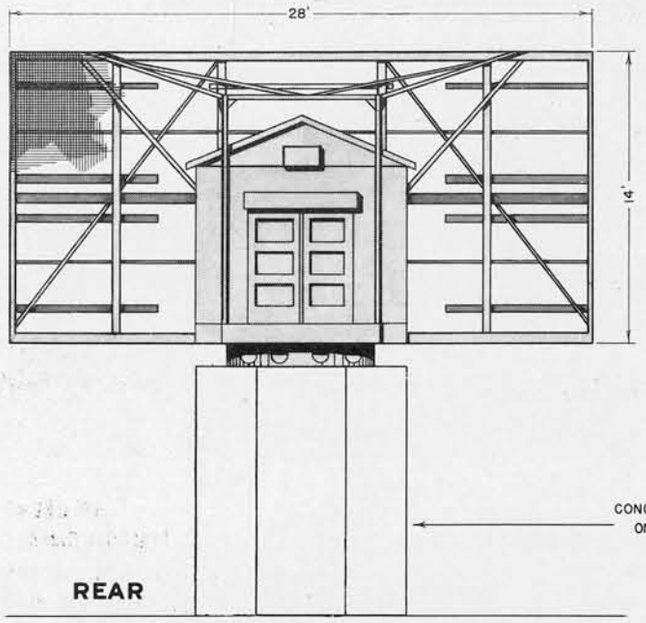
RADAR
ATTU TYPE

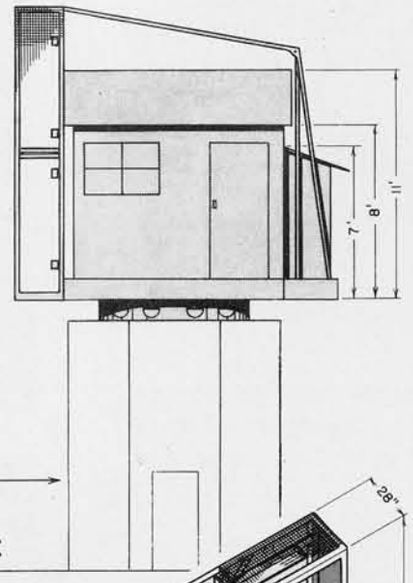
This radar, hereafter called the "Attu" type, was in an unassembled state when first found at Attu, Aleutians.

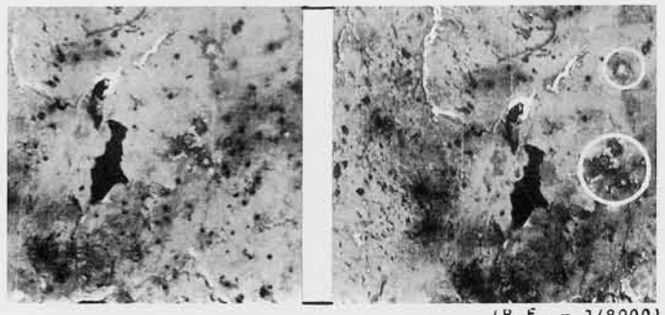
Electrically, it is very similar to the Guadalcanal type but is, in general, an improved modification. As of November 1944, it is still being used by the Japanese to a considerable extent in all areas.

The most important identification factor, the box screen, is not present in these photos. Spotting of radar positions in aerial photos is largely dependent on screens and screen shadows. Below are shown drawings reconstructing the "Attu" type radar, shown on this and several following pages.

ATTU, ALEUTIANS

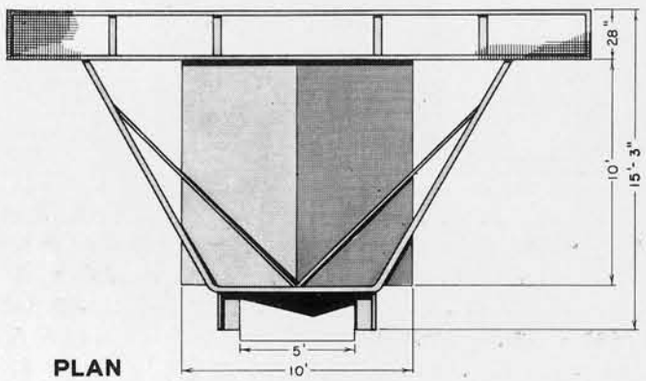


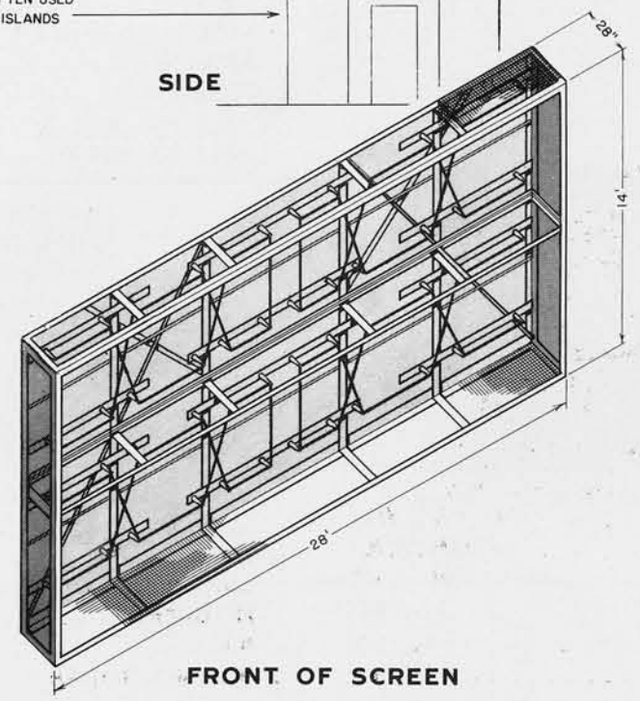


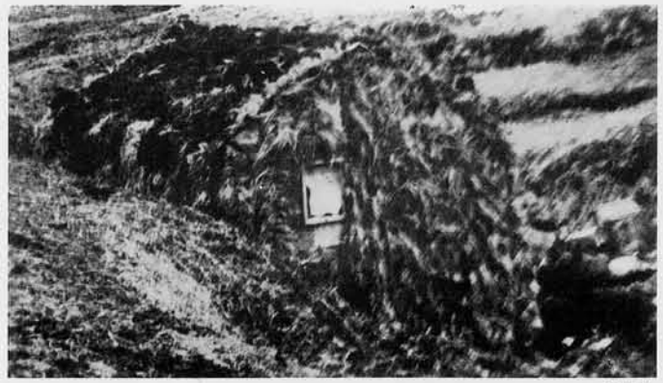


ATTU, ALEUTIANS (R.F. - 1/8000)

The first example found of the Attu type Radar was still in the process of construction. These views will illustrate the extreme difficulty of spotting radar without its best identifying characteristic -- the screen. Shown below is a well camouflaged generator house, also very difficult to detect in aerial photos.



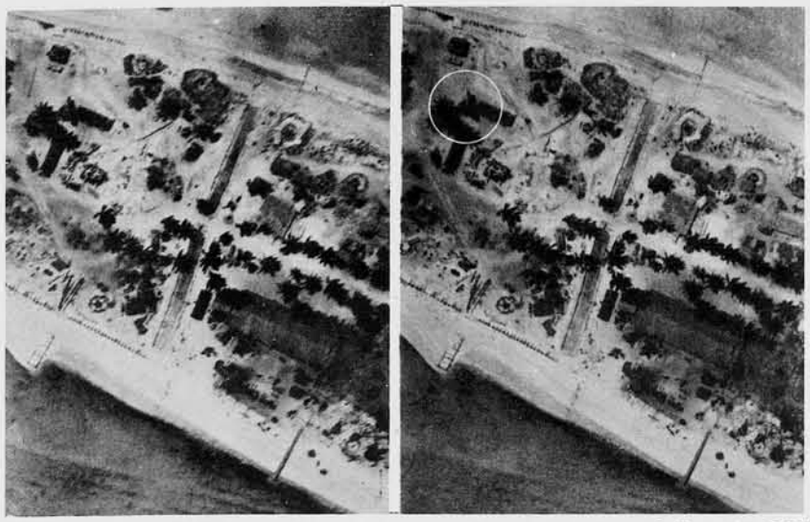




LOCATION	ATTU
TYPE. (MARK I, MODEL I, MODIF. I)	"ATTU"
ANTENNA	28' x 14' x 2 1/3'
FREQUENCY	100 MCS
P.R.F. .....880 - 1200 ....PULSE	12 - 30
MAXIMUM RANGE	75 N. MI.

CONFIDENTIAL

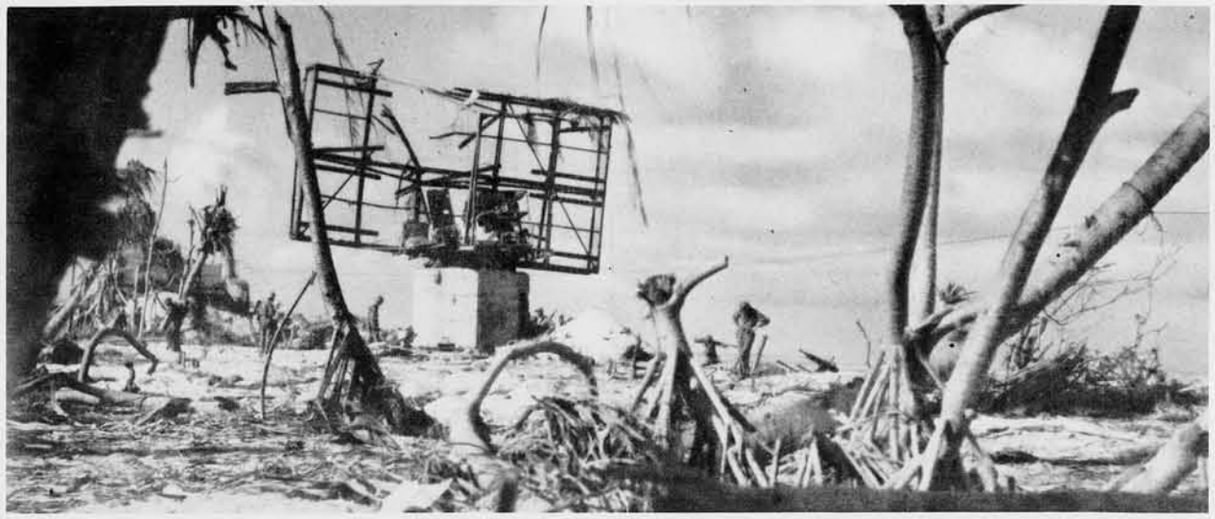
RADAR
ATTU TYPE (CONT.)



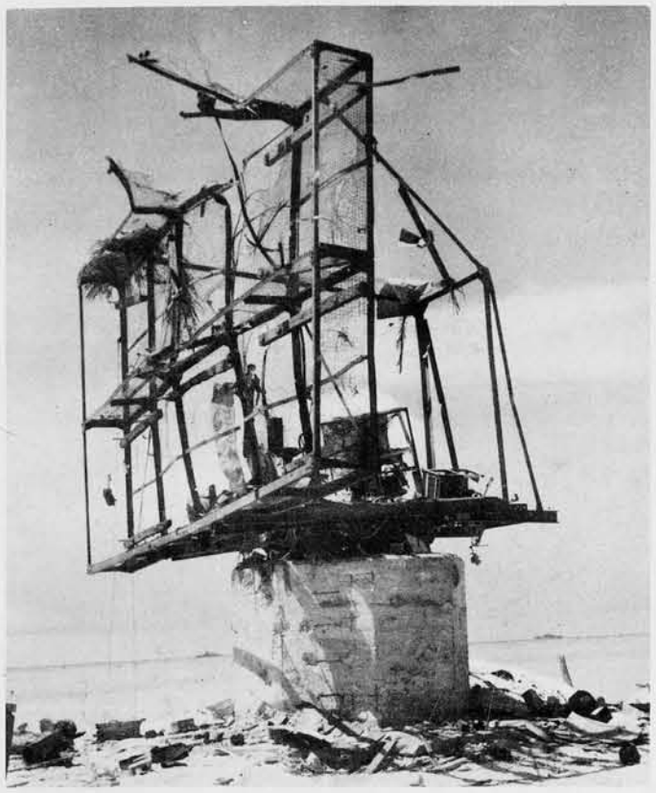
(R.F. - 1/2000)

TARAWA, GILBERTS

ABOVE: Radar near east tip of Bititu

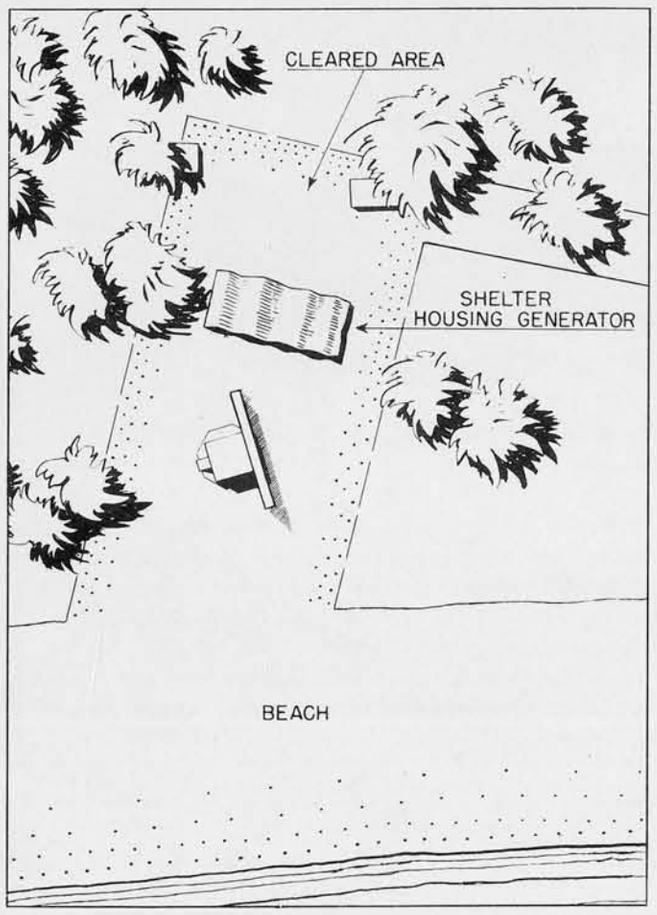


TARAWA, GILBERTS



TARAWA, GILBERTS

ABOVE: Note the horizontally elongated box-like shape of the screen of the ATTU type in contrast to the two dimensional more squared shape of the Guadalcanal type on previous pages.



TARAWA, GILBERTS

TARAWA, GILBERTS

ABOVE: Radar on west end of Bititu.

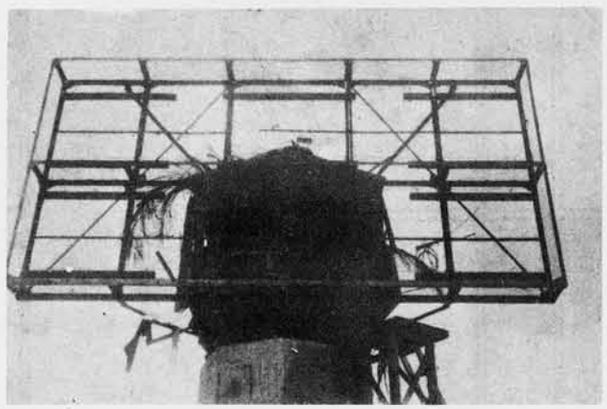
At Bititu Island, Tarawa Atoll were two Attu type radars of identical design. One was at the west end and the other a few hundred feet from the east tip. Both were set on high concrete bases and were used for different sectors of the air and surface search.

LOCATION	TARAWA
TYPE. (MARK I, MODEL I, MODIF. I)	"ATTU"
ANTENNA	28' x 14' x 2 1/3'
FREQUENCY	100 MCS
P.R.F. 880 - 1200 PULSE	12 - 30
MAXIMUM RANGE	75 N. MI.

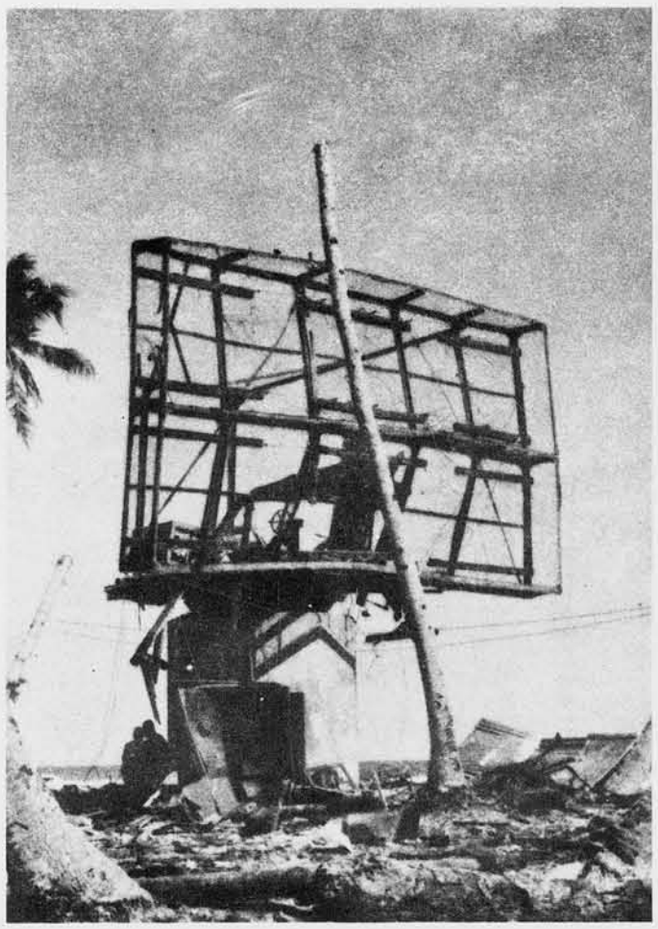
RADAR
ATTU TYPE (CONT.)

MAKIN, GILBERTS

ABOVE AND BELOW: Two views of Radar at end of Stone Pier. Concrete base is 18 feet high. Note pitched roof of "Attu" type.



MAKIN, GILBERTS



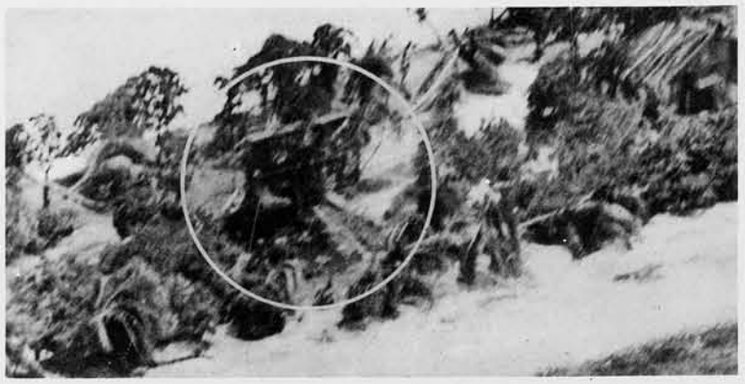
MAKIN, GILBERTS

ABOVE: Radar on South Coast. Concrete base is 8 feet high.

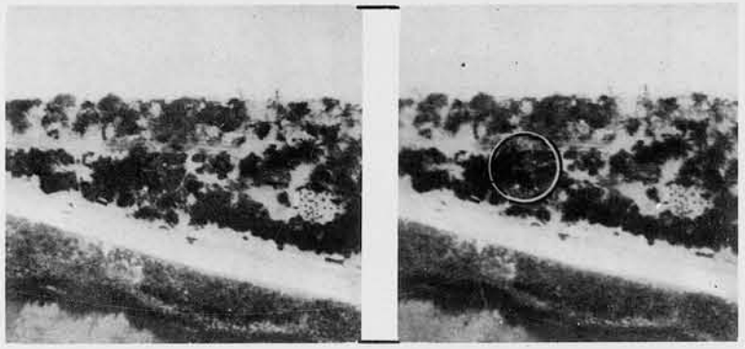
The two Radar installations on Makin are of the same design as at Tarawa and were installed in October 1943. The control shacks rotate with the screens on steel turntables to afford complete search coverage.

The high concrete bases afford greater range for surface search.

LOCATION	MAKIN
TYPE. (MK. I, MODEL I, MODIF. I)	"ATTU"
ANTENNA	28' x 14' x 2 1/3'
FREQUENCY	100 MCS
P.R.F. 880 - 1200	PULSE 12 - 30
MAXIMUM RANGE	75 N. MI.

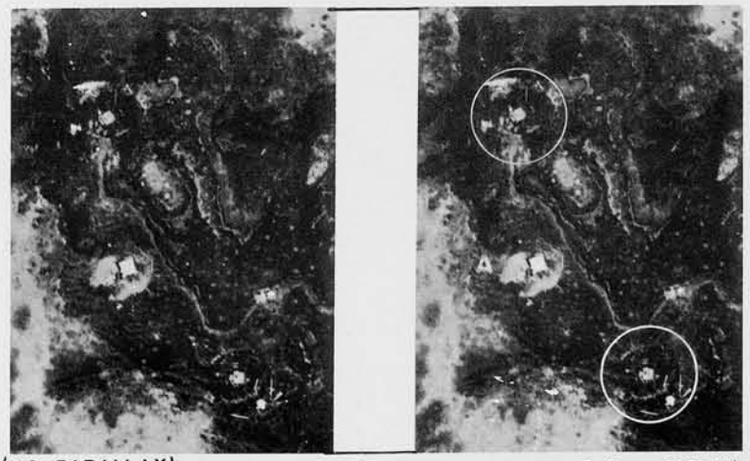


MILLE, MARSHALLS



MILLE, MARSHALLS

Same Radar on Mille, now cleared of vegetative camouflage.



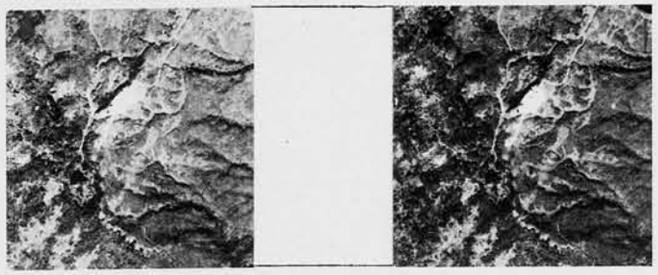
(NO PARALLAX) (R.F. - 1/3500)

KAKUMABETSU WAN, PARAMUSHIRO

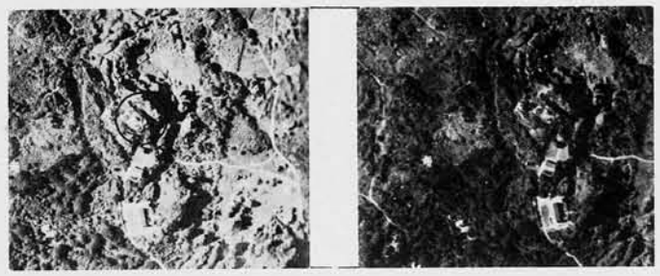
LOCATION	MILLE & PARAMUSHIRO
TYPE. (MK. I, MODEL I, MODIF. I)	"ATTU"
ANTENNA	28' x 14' x 2 1/3'
FREQUENCY	100 MCS
P.R.F. 880 - 1200	PULSE 12 - 30
MAXIMUM RANGE	75 N. MI.

RADAR
ATTU TYPE (CONT.)

Numbers 1, 2, 3, 4, 5, and 6 on this page show the "Attu" type Radar at various scales for analytical study and comparison. The "Attu" type is widely used by the Japanese at present and its outward appearance in vertical photography is familiar to many interpreters. Although no information is available on the use of German equipment by the Japanese, a Small Wurzburg is shown here for further comparison in #4: "A"-Attu; "B"-Wurzburg.



LOCATION . . . . . IWO JIMA
TYPE. (MK I, MODEL I, MODIF. I) . . . . . "ATTU"
ANTENNA . . . . . 28' x 14' x 2 1/3'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . PULSE . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

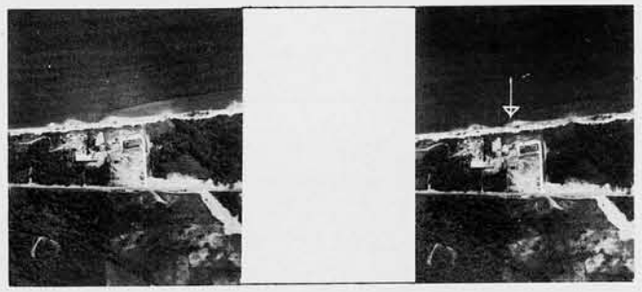


LOCATION . . . . . OKAYAMA, FORMOSA
TYPE. (MK. I, MODEL I, MODIF. I) . . . . . "ATTU"
ANTENNA . . . . . 28' x 14' x 2 1/3'
FREQUENCY . . . . . 100 MCS
P.R.F. . . . . 880 - 1200 . . . . . PULSE . . . . 12 - 30
MAXIMUM RANGE . . . . . 75 N. MI.

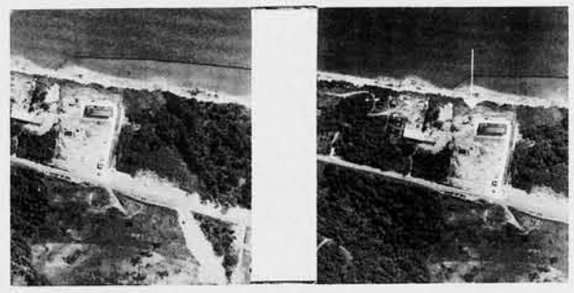
ABOVE: These two examples in the Kazans and on Formosa appear to be "Attu" type installations:

In both examples other related activities, such as communications, generating of power, and living and working quarters are present.

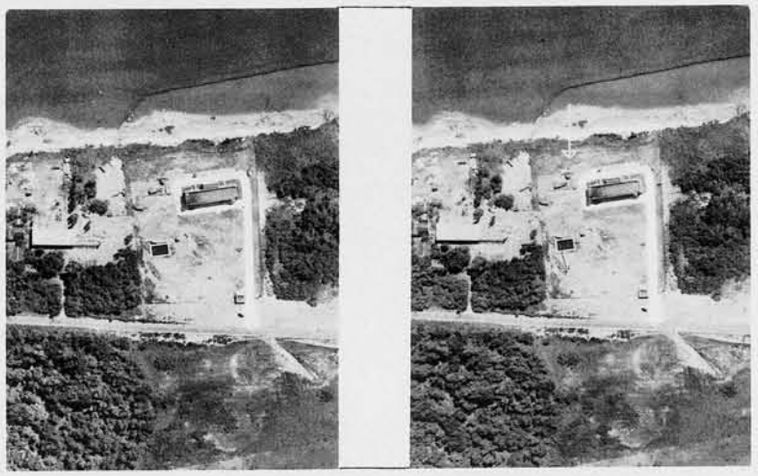
The Okayama set is 10 miles inland from the coast and both are situated on high points of land.



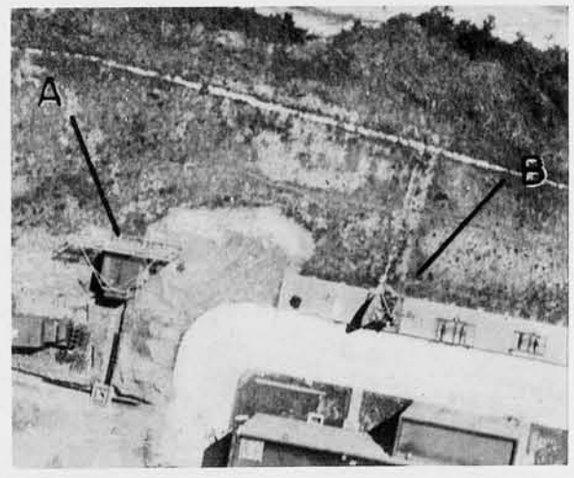
1 (R.F. - 1/15000)



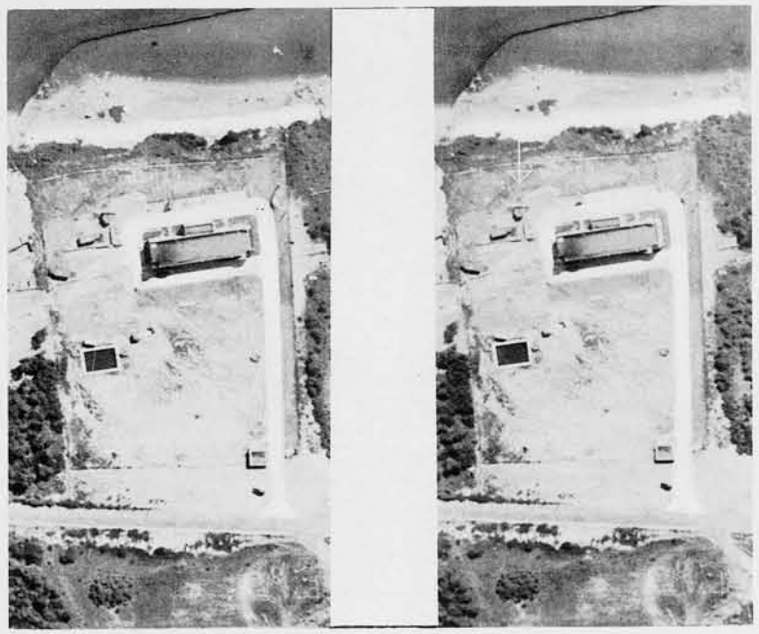
2 (R.F. - 1/10000)



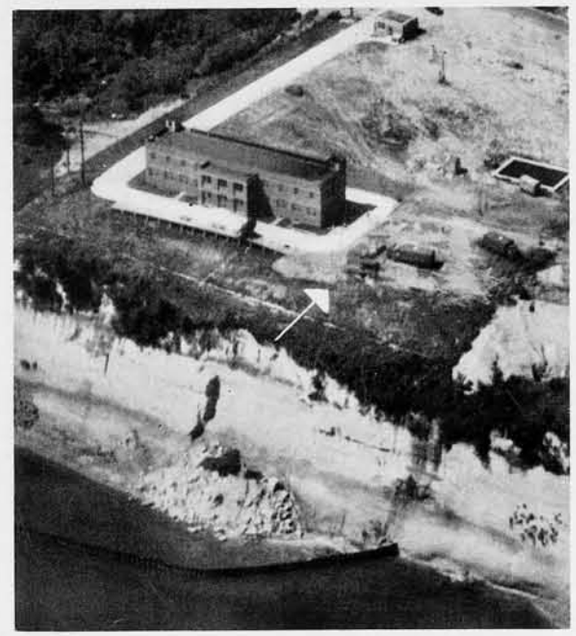
3 (R.F. - 1/5000



4 (R.F. - 1/1000)



5 (R.F. - 1/2600)



6 12" OBLIQUE AT 1000'

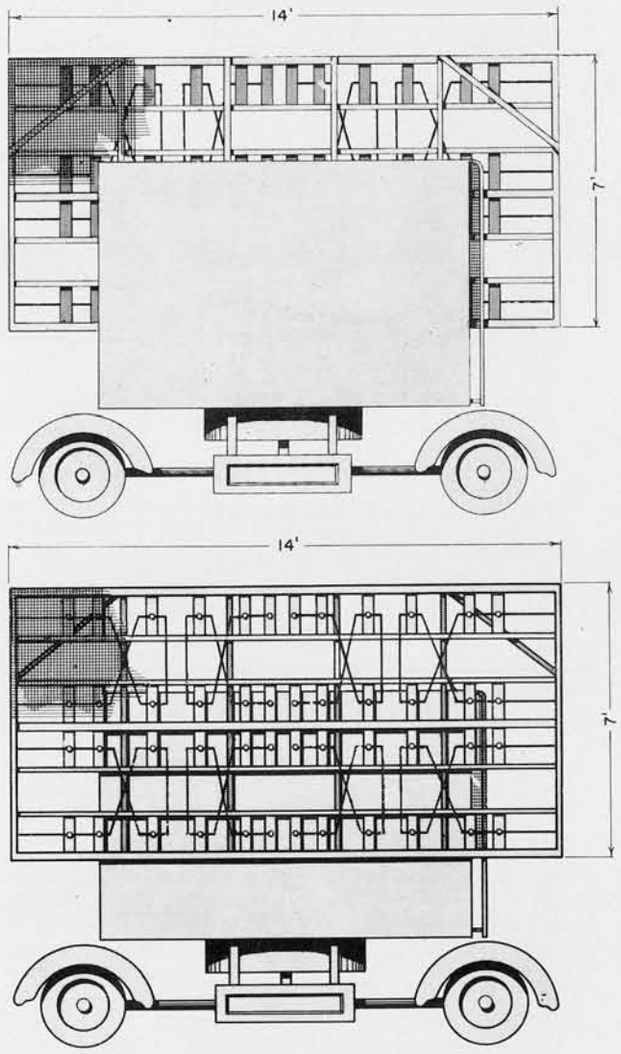
RADAR
MOBILE MATTRESS

A later, and apparently more efficient, Radar type is the "Mobile Mattress" or "Mark I, Model II". The Radar operates at 200 mcs. and is identified by a small screen (14' x7') mounted on a Japanese standard army trailer (type 94).

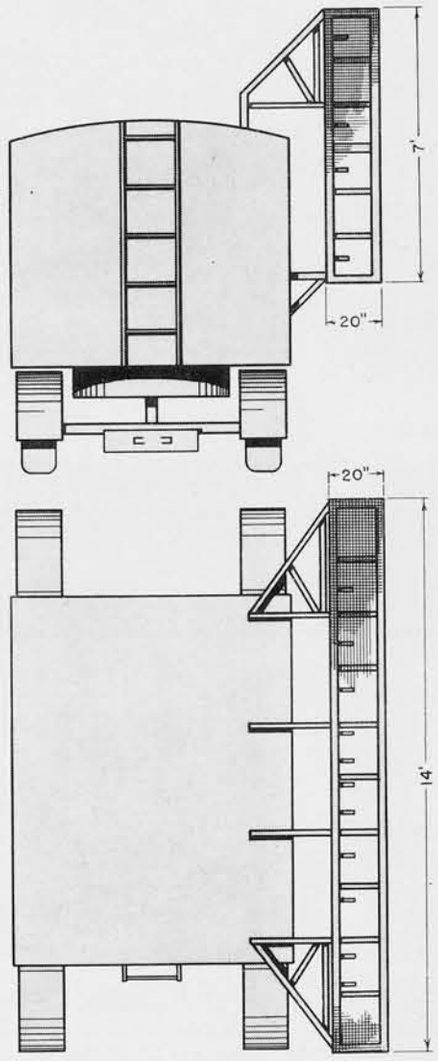
This Radar is being used more and more for land-based search, either alone or in conjunction with older types. It is frequently seen mounted in emplacements, suggestive of a permanent siting.

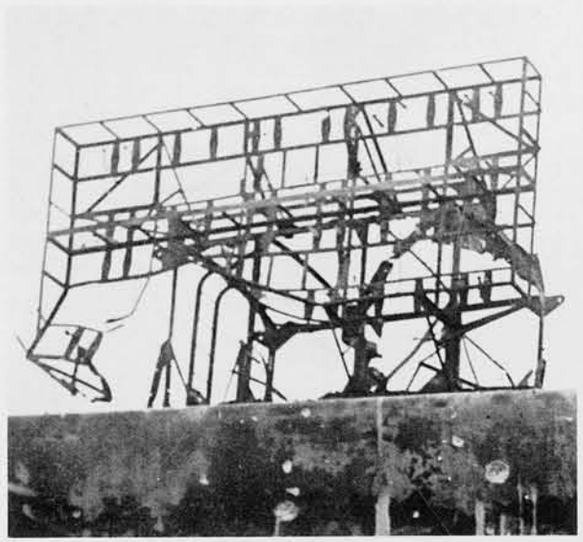
Below are reconstructed drawings made from photos of the Kwajalein set.

The shack, antennae, revolving mount and trailer may be separated for shipping purposes.

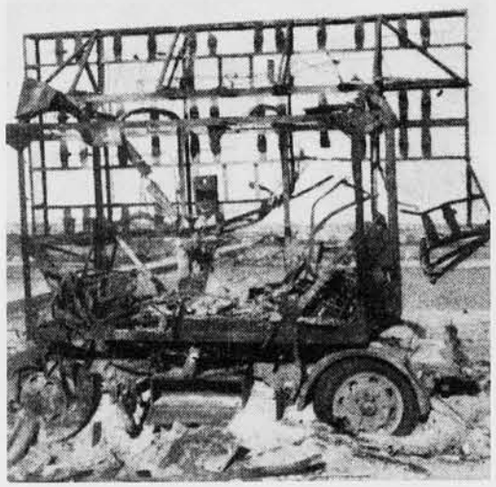


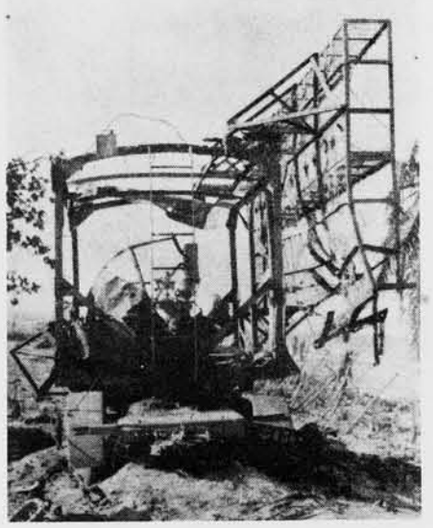
SHACK AND SCREEN ROTATE ON TURNTABLE





NAMUR, KWAJALEIN, MARSHALLS





NAMUR, KWAJALEIN, MARSHALLS

LOCATION	KWAJALEIN
TYPE (MK. I, MODEL 2)	"MOBILE MATTRESS"
ANTENNA	14' x 7' x 1 2/3'
FREQUENCY	200 MCS
P.R.F. 800 - 1500 PULSE	3 1/2 - 12
MAXIMUM RANGE	100 N. MI.

The Mobile Mattress captured at Namur, Kwajalein, was mounted atop the standard concrete power house. Although the set is badly damaged, it is still possible to establish the important recognition features.

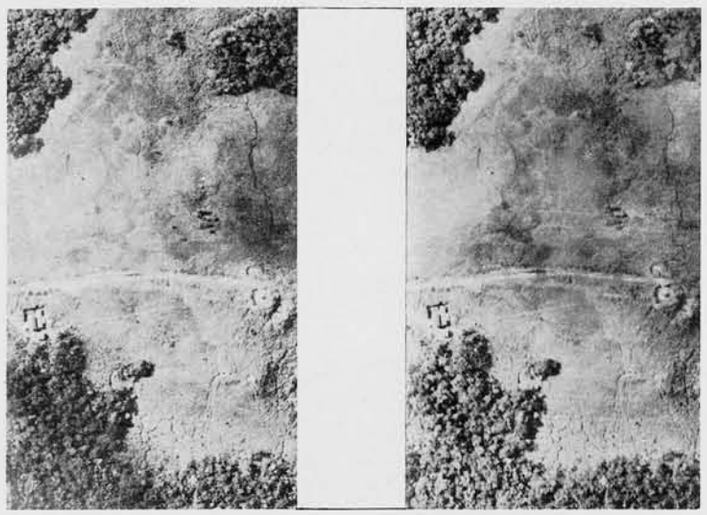
Note the similarity in design between this and the Attu type screen. The Mobile screen is much smaller, however.

RADAR

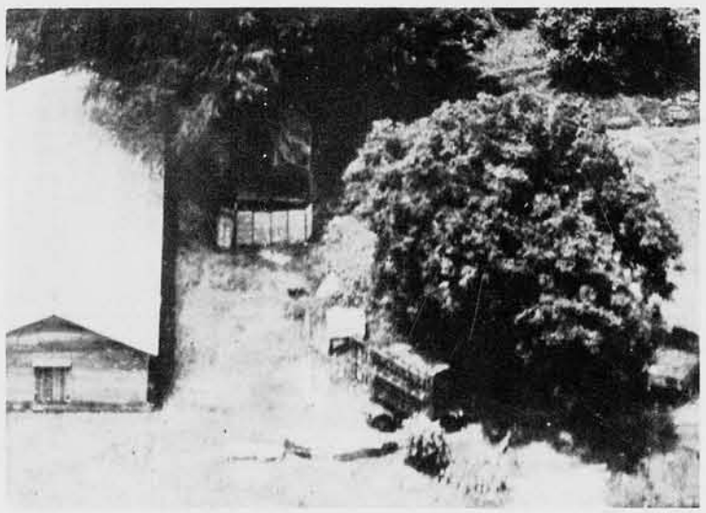
MOBILE MATTRESS (CONT.)

Several additional views of the "Mobile Mattress" or Mark I, Model 2 are shown for familiarization. This set is very probably the best Japanese Search Radar in general use at present. The frequency is 200 megacycles per second and the maximum range is 100 nautical miles.

SATAWAN, CAROLINES

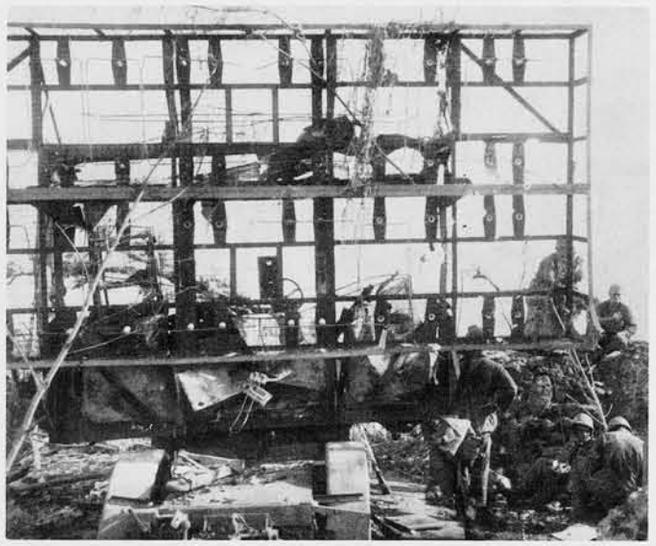


PONAPE, CAROLINES (R.F. - 1/14750)



RABAUL, NEW BRITAIN

TINIAN, MARIANAS



TINIAN, MARIANAS

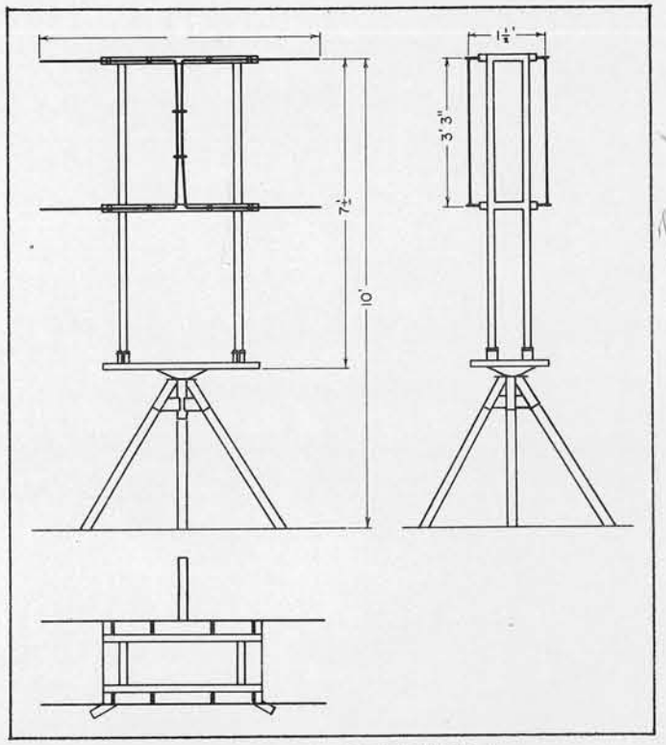
TINIAN, MARIANAS

TINIAN, MARIANAS

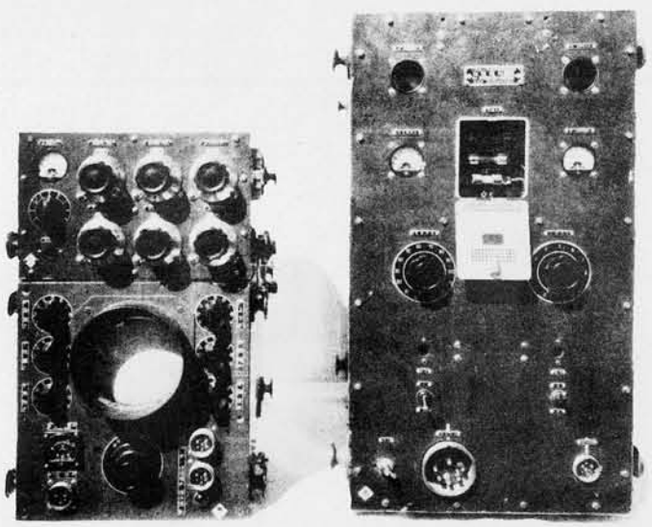
CONFIDENTIAL

RADAR
PORTABLE TYPES

LOCATION . . . . . PORTABLE
TYPE . . (AIR MK 6 "SPECIAL") . . . "MARK 6 PORTABLE"
ANTENNA . . . . . DIPOLES
FREQUENCY . . . . . 150 MCS
P.R.F. . . . . 1000 . . . PULSE 3-5
MAXIMUM RANGE . . . . . 30 N. MI.



MARK 6 PORTABLE

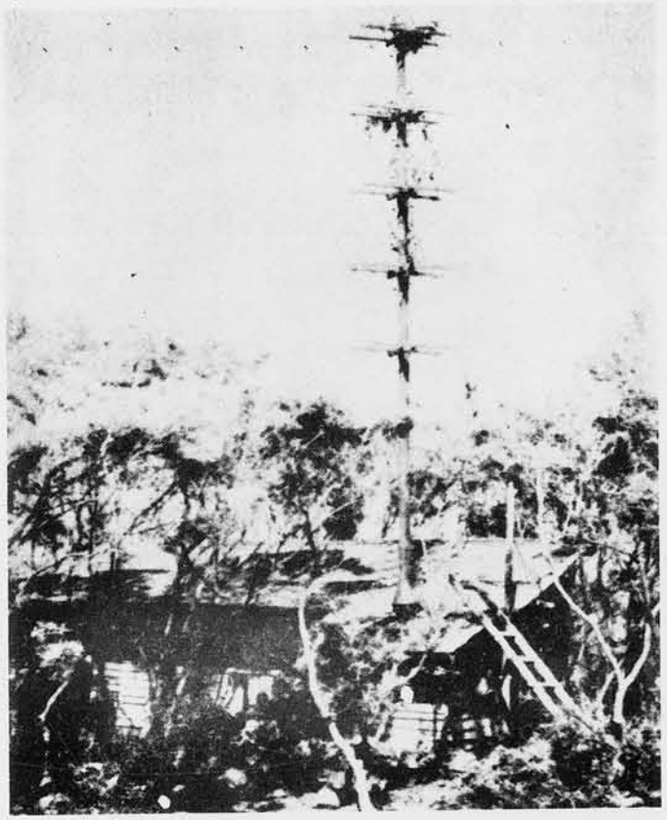


MARK 6 MODEL 4 EQUIPMENT

MARK 6 PORTABLE

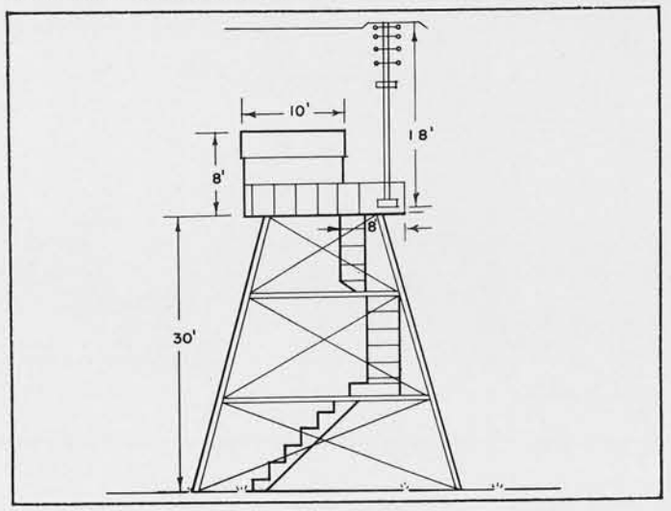
ABOVE AND LEFT COLUMN: This portable Radar ("Mark 6 Portable") is an adaptation of the same set used in aircraft for search (Mark 6, Model 4), and its characteristics are believed to be similar to the original airborne model. When in operation, the Radar gear, shown at lower left, rests on the lower shelf and the whole is supported by a collapsible tripod. The dipoles are approximately 7 feet long. This set was found on Guam.

RIGHT COLUMN: The "Mark 13 Portable", (temporary designation Mark 1, Model 3) is believed to be essentially the same set as the "Mark 6 Portable" with certain modifications including higher power and greater range. The mode of construction at the site may vary considerable with this Radar. The above ground shot shows improvised antenna at Saipan. At Goerango Point, Moratai, the antenna, all equipment and control shack were mounted on a tower 30 feet in height. Note that in both cases, however, the antenna consists of a stack of dipoles.



MARK 13 PORTABLE

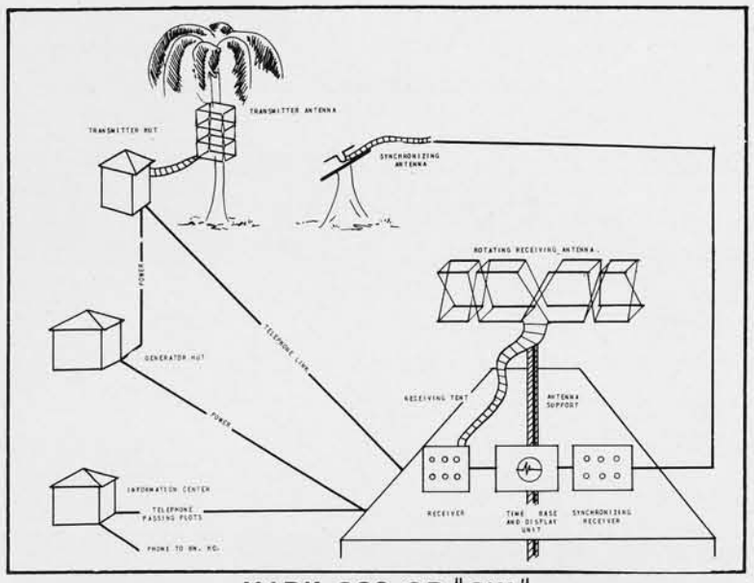
LOCATION . . . . . PORTABLE
TYPE . . . (MK 1, MODEL 3) . . . . . "MK 13 PORTABLE"
ANTENNA . . . . . 7' DIPOLES
FREQUENCY . . . . . 150 MCS
P.R.F. . . . . 500 . . . . PULSE 10
MAXIMUM RANGE . . . . . 45 N. MI.



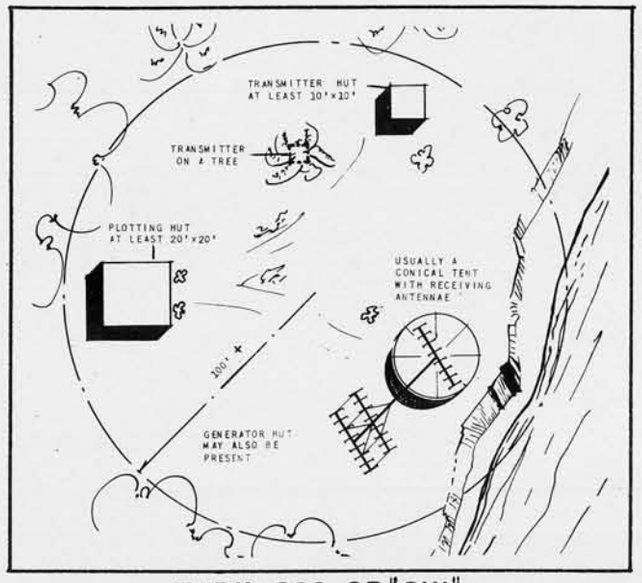
MARK 13 PORTABLE

CONFIDENTIAL

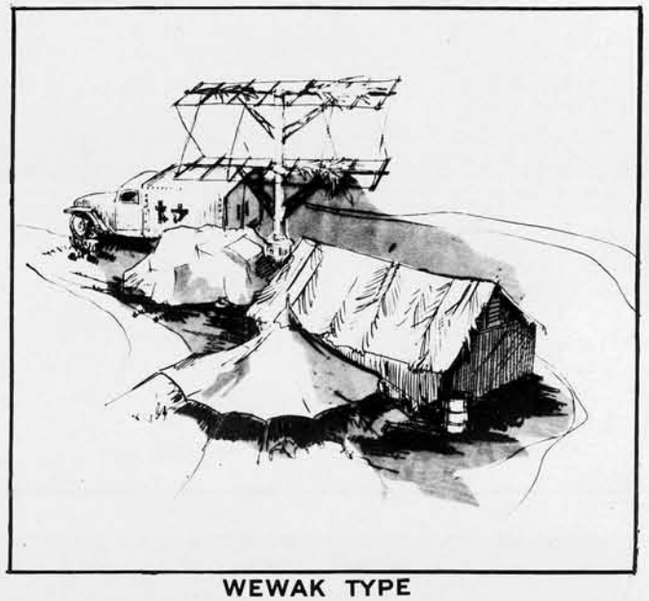
RADAR
PORTABLE TYPES



MARK 229 OR "CHI"

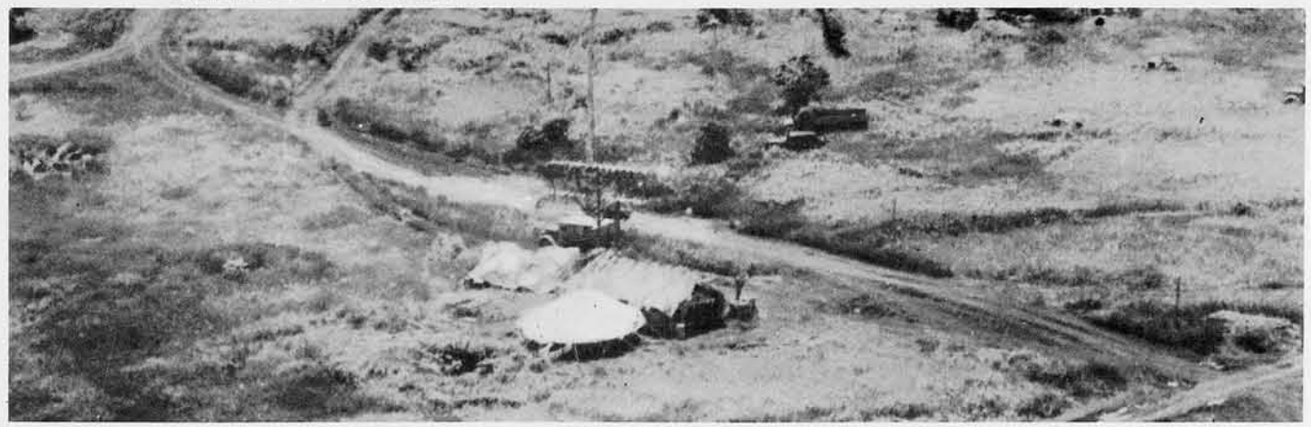


MARK 229 OR "CHI"



WEWAK TYPE

WEWAK TYPE



WEWAK TYPE

Information on the exact designations, characteristics and use of the 70 megacycle Radars are not entirely clear at this time. However, they may be reasonably broken down into two main subdivisions:

(1) A transportable (possibly mobile) type which was first seen at Wewak in 1943 and which has been called the "Wewak" type or "Ya".

(2) A type which may be transportable but entails the use of a separated small non-directional transmitter which is fixed (often attached to the trunk of a tree under the foliage). This type is known as "Chi" or Mark 229.

TYPE ("YA")	"WEWAK"
ANTENNA	20' x 7' x 4'
FREQUENCY	70 MCS
P.R.F. 750 PULSE	25 - 35
MAXIMUM RANGE	125 N. MI.

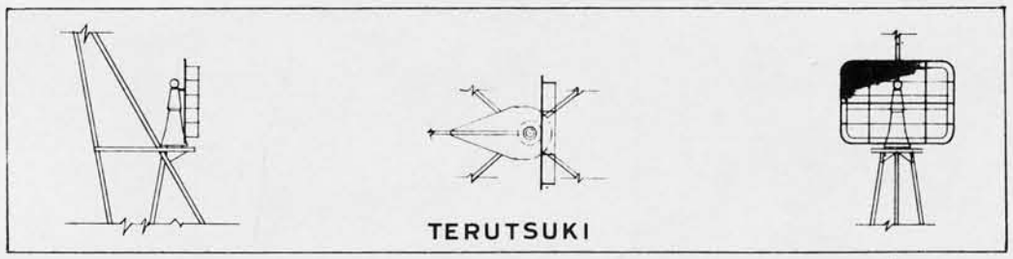
The best recognition feature for the 70 megacycle Radars is the 20' array set on top of a pole. Rough dimensions are as follows: Overall length of row of dipoles - 20'; length of dipoles - 7'; vertical separation between rows of dipoles - 7'; overall height above ground - 25'. The entire shaft and dipoles rotate.

This equipment has the greatest range of most known Japanese Radars now in production and undoubtedly enjoys wide useage in certain areas for early warning purposes. It possesses the advantages of being transportable and is easily camouflaged.

TYPE (MK 229)	"CHI"
ANTENNA	20' x 7½' x
FREQUENCY	70 MCS
P.R.F. 750 PULSE	25 - 35
MAXIMUM RANGE	125 N. MI.

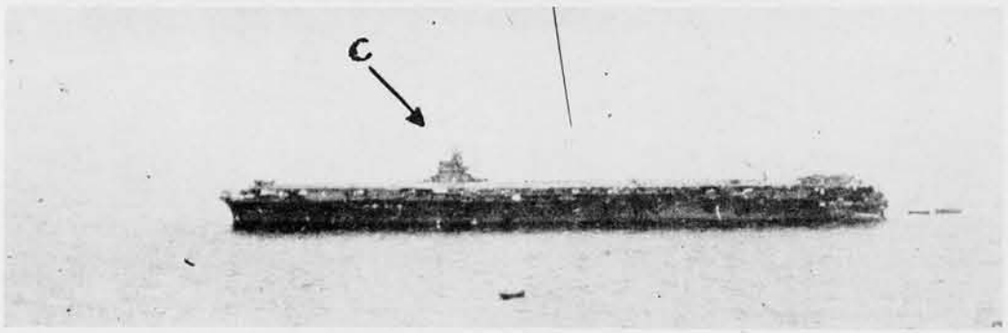
RADAR
SHIP BORNE TYPES

NATCHI CA

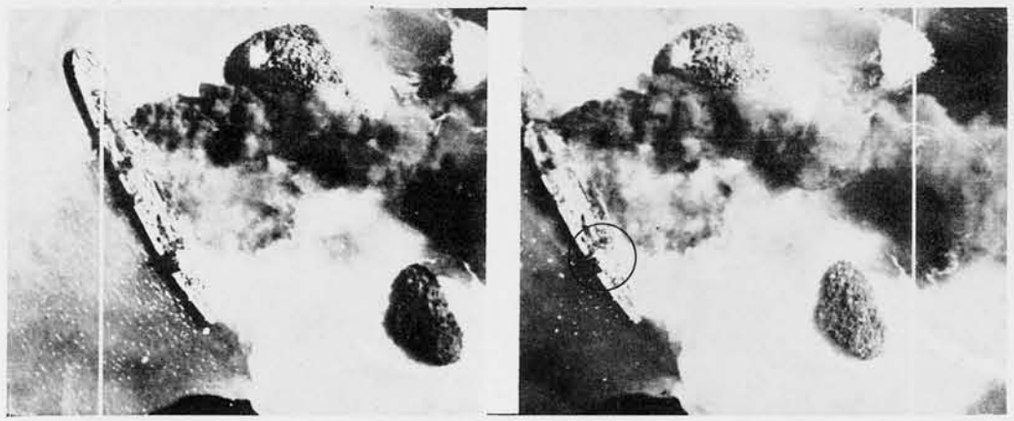


SIDE PLAN FRONT

TERUTSUKI DD



SHOKAKU CV



NAVAL TENDER

There are two basic Radar types in use by the Japanese Navy afloat at the present time. One is a 200 Mcs. search Radar with a mattress type antenna, the other is a 3000 Mcs. Radar for surface search and surface fire control, using electromagnetic horns. (A 150 mcs. Search Radar has been reported)

Search Radar has been photographed many times on Japanese naval vessels and is usually located at the highest point of the ship, except on aircraft carriers, where there are two sets. This search Radar is Mark 2, Model I or "Ship Mattress" and is designed primarily for early warning against planes.

LOCATION	SHIPBORNE
TYPE . . . . (MOST ARE MARK 2, MODEL I)	"SHIP MATTRESS"
ANTENNA	14' x 7' x 1.67'
FREQUENCY	200 MCS
P.R.F. . . . . 1000 . . . . . PULSE	10
MAXIMUM RANGE	100 N. MI.

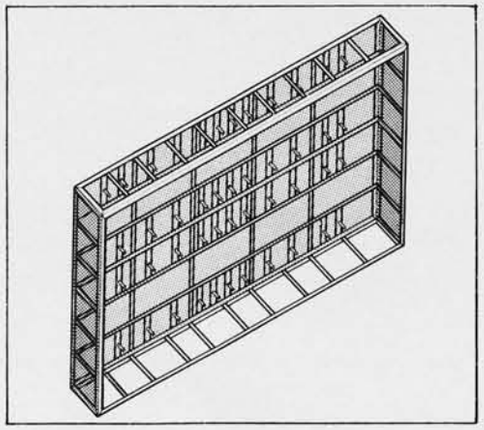
TAIHO CV

"A" - Two Mark 2, Model I antennae, one mounted foreward and the other abaft the island of the CV "Taiho", new Japanese carrier.

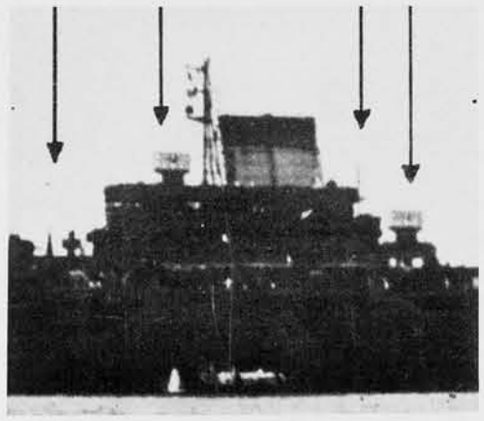
"B" - Two Medium Frequency Loop Type Direction Finders.

"C" - Mark 2, Model I antenna mounted on top of the island superstructure of the CV Shokaku. (See left)

The "Ship Mattress" or Mark 2, Model I antenna (see drawing below) is thought to be almost identical to that of the "Mobile Mattress", a land based Radar. This type is believed to be the most widely used, at present, for shipborne air warning equipment.



SHIP MATTRESS ANTENNA

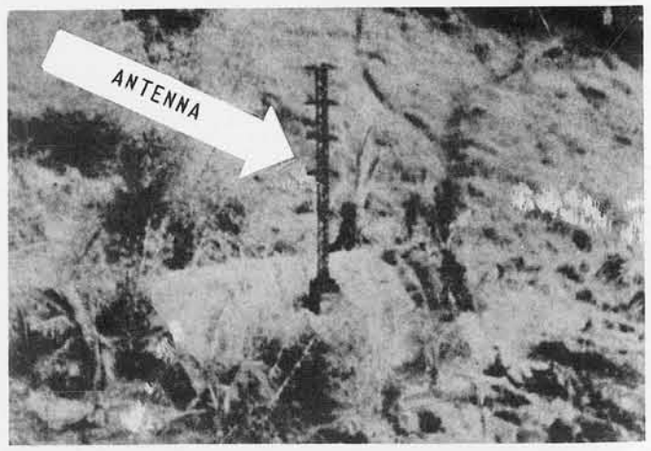


CV TAIHO, DETAIL OF ISLAND

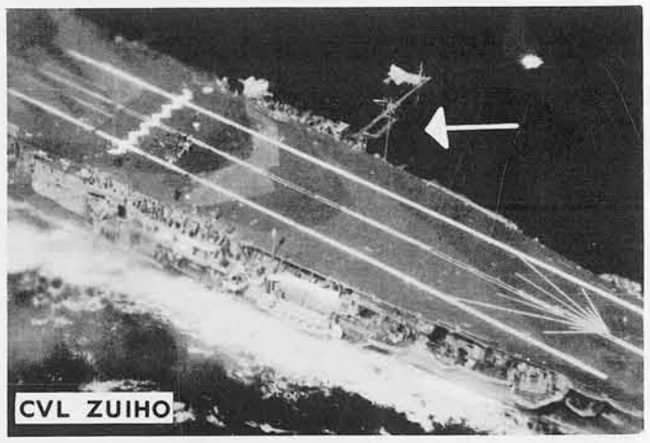
1 APRIL 1945

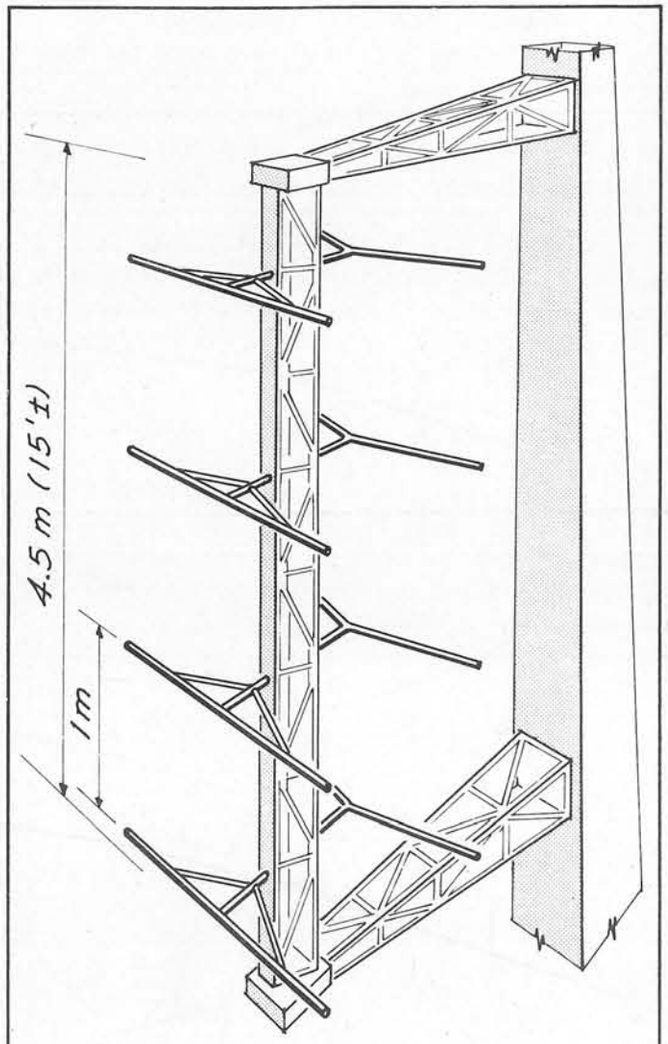
"LADDER TYPE" ship borne air search radar has been observed on the CVL Zuiho, CA Nachi Class, CA Atago Class, and on Terutsuki, Shimakaze, Takanami, and Fubuki (Amagiri Group) Class destroyers. This set is thought to be the ship borne adaptation of the land-based Mark 1 Model 3 radar, operating on 145--175 Mcs., and is reportedly designated Mark 2 Model 4 by the Japanese. The "LADDER TYPE" is mounted on the mainmast of the destroyers pictured, a factor which appears to limit the effectiveness of search astern. Photographs of Terutsuki Class DD's reveal the "LADDER TYPE" in addition to the "MATTRESS TYPE" carried on the foremast.

LOCATION	"SHIP BORNE"
TYPE (Probably Mk. 1, Mod. 3 adaption)	"LADDER TYPE"
ANTENNA	1 meter DIPOLES
FREQUENCY	150 Mcs.
P.R.F. 500	PULSE 10
MAXIMUM RANGE	60 N. MI.

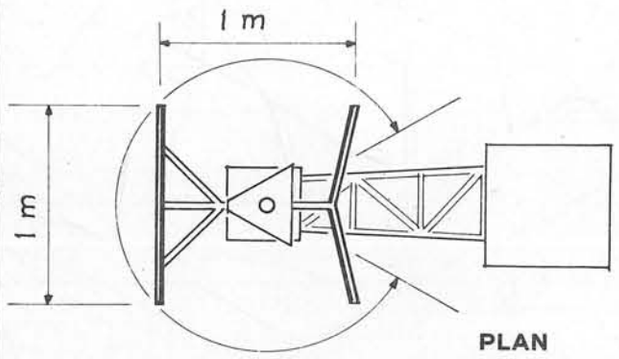


LAND BASED MK. 1 MOD. 3



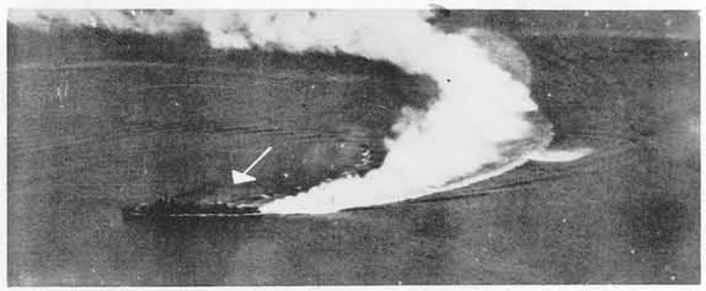


PERSPECTIVE



PLAN

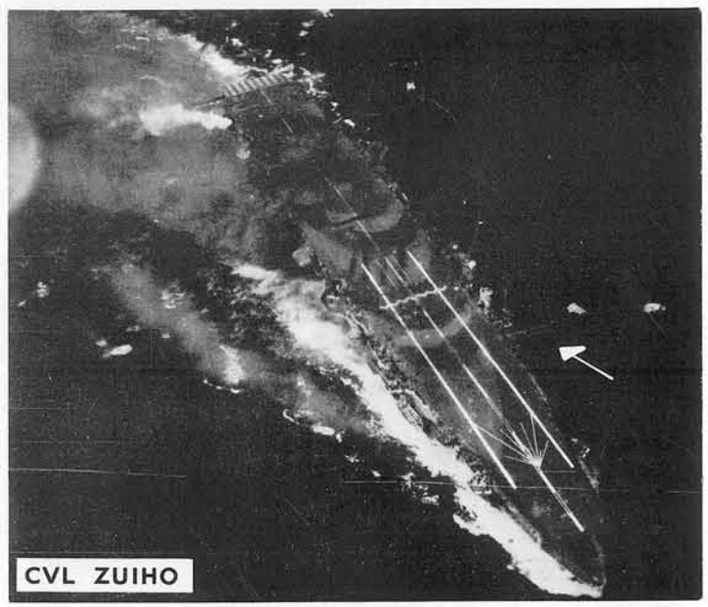
PROVISIONAL DRAWING OF SHIP BORNE "LADDER TYPE"



DD TAKANAMI CLASS

DD TAKANAMI CLASS

DD SHIMAKAZE CLASS



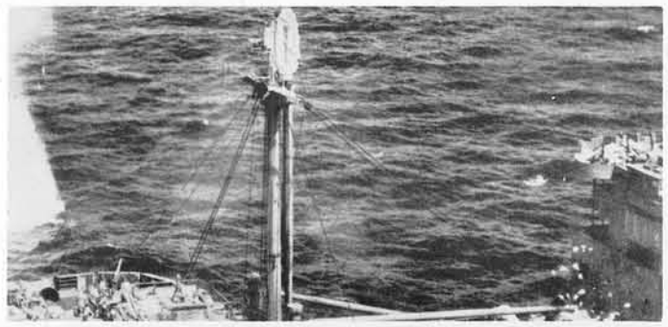
RADAR

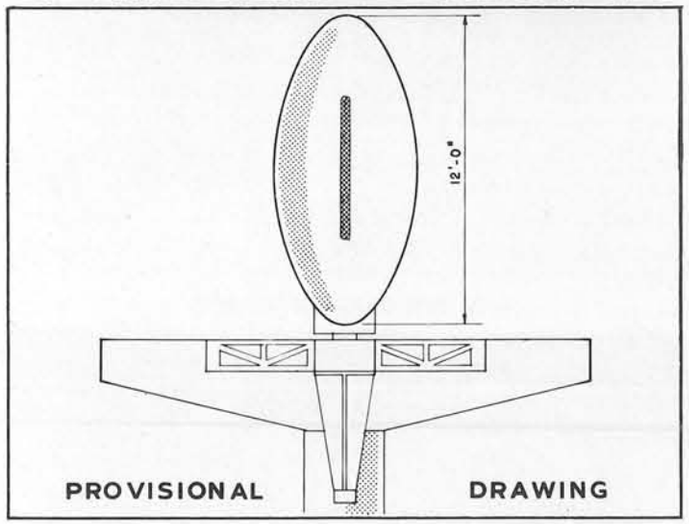
SHIP BORNE TYPES

1 APRIL 1945

SUSPECTED NEW TYPE SHIP BORNE RADAR

Suspected Mark 2 Model 3 ship borne radar antennae were observed on the foremast and mainmast of a Type B special amphibious ship, the Takatsu Maru. A canvas covering which appears to be on the foremast antenna precludes detailed interpretation. POW reports and captured documents indicate use of a paraboloid ship borne search and fire-control radar designated Mark 2 Model 3 and operating on 517 Mcs.

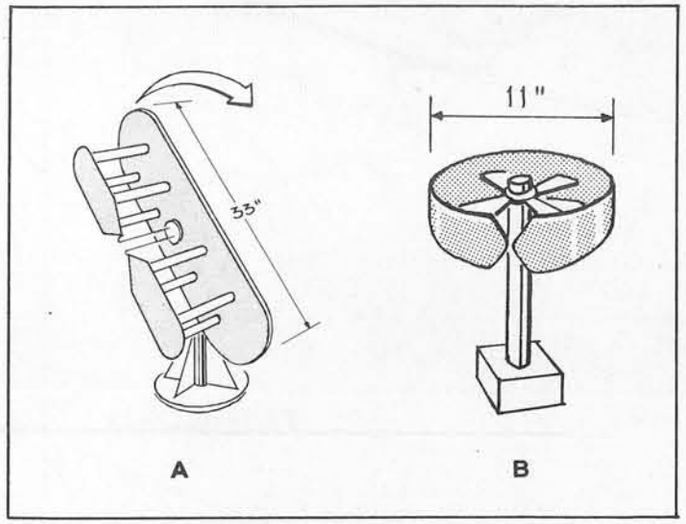


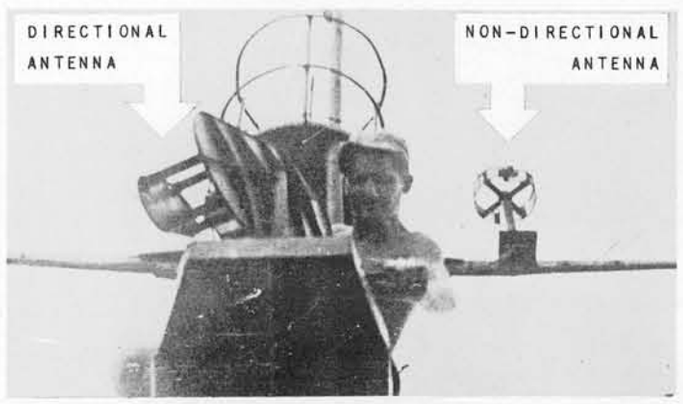


RADAR SEARCH RECEIVER

Radar Search Receiver (or Detector) gear has been recovered from several Japanese vessels sunk off Leyte. This apparatus receives transmitted radar waves and has been used by the Japanese for interception of our radar transmissions, thereby serving as an "early-warning" device.

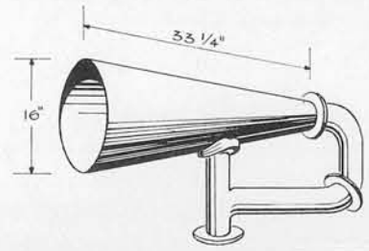
The RSR antennae recovered were of two types: (a) Directional (rotating antenna) mounted on a small pedestal fitted to the foremast slightly above the bridge; and (b) Non-directional (non-rotating antenna) mounted on the forward yardarm. Two sizes of Directional antennae were found: a large type (22" wide x 54" long) made of wire mesh; and two small types (12" x 33" long), one made of wire mesh and the other constructed of a solid metal plate (see (A) below). Both large and small Directional antennae were of the same shape. The Non-directional antennae were constructed of wire mesh and measured 11" in diameter.

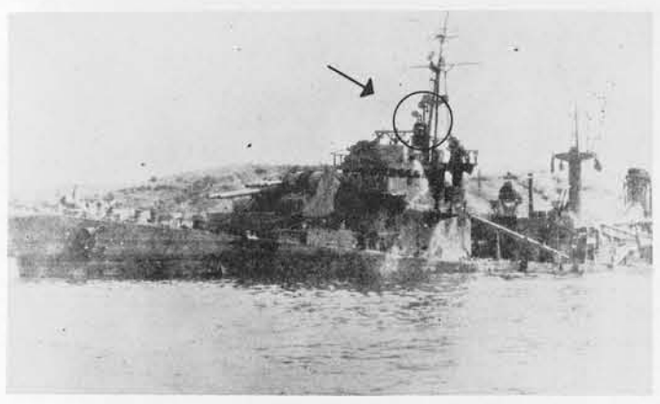




MK. 2 MOD. 2 MODIF. 4 RADAR

A "Two-Horn" surface search radar was recovered from a sunken APD in San Isidro Bay, Leyte. The horns are of identical shape and size and were mounted on a square steel tower secured on the after part of the bridge immediately forward of the foremast. The horns are geared to rotate in synchronism and apparently can be turned manually or electrically. The name plate on the set indicated this to be a temporarily designated Mark 2 Model 2 Modification 4 Radar.





CONFIDENTIAL

Drawings of the Electromagnetic horn antennae of the Mark 2, Model 2 Radar are shown on this page.
The Japanese have met with many difficulties in the early development of this "micro-wave" set. Nevertheless, it is now believed to be functioning in a satisfactory manner. P.O.W.'s have reported that it is now used widely throughout the fleet with good results. In that the information on which these drawings were based (lower right) is now over a year old, changes in appearance are quite possible.

However, the configuration will undoubtedly consist of horns similar to the drawings shown on this page. The horn dimensions and the design of the turntable may vary somewhat.

Excerpt from a captured Japanese notebook, probably written from class lecture early in 1944, presents the Japanese problem in Naval Radar. The lecturer is discussing the use and development of Mark 2 Model 1, "Ship Mattress" Radar.

"However it was immediately apparent that it would be difficult to use the set for fire control since this would require range and bearing accuracy beyond the scope of a set designed primarily as a warning device. Nevertheless, the exigencies of war demanded that this set be used for other purposes than those of a mere warning device. Since the set was to be used for fire control, the improvement of range and bearing accuracy was given top priority and the present supplementary equipment was placed in trial production. With the addition of this equipment, the expected results were obtained, but though its sensitivity was enough for a set designed primarily as a warning device, it was still not accurate enough for effective fire control making fullest use of measurement data. It is hoped that great improvements in performance may be expected with the early production of radar designed solely for fire control. (ED: Probably Mk. 2, Model 2, Modif. 12)

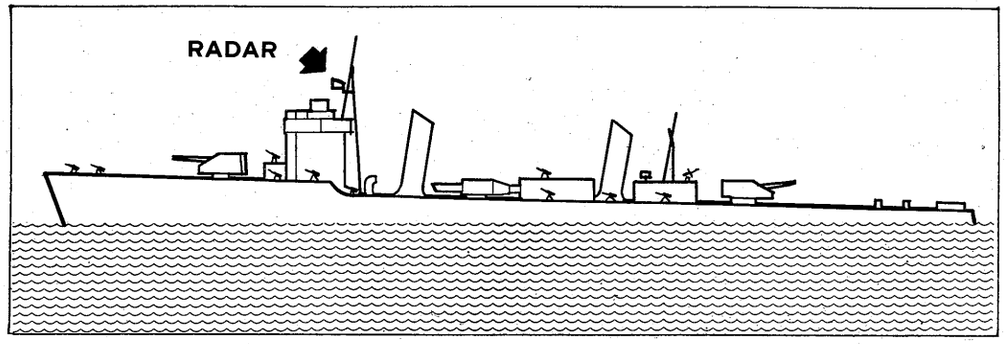
But in the present stage of the war we must get the most out of our present equipment, and not vainly discuss the possibilities for the future. Various methods of dealing with this problem are now under study."

Recent P.O.W. information indicates that many types of Naval Vessels are now equipped with Mark 2, Model 2 and modifications. Knowledge of the present status and performance of the equipment is still somewhat hazy, but interpreters should examine all ships for presence of electro-magnetic horns.

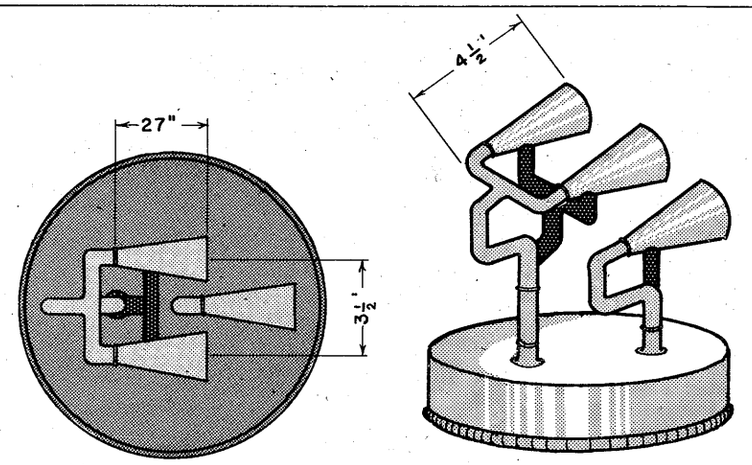
In most vessels, the likely location for the horns is near the top of the foremast or foreward superstructure. On aircraft carriers, they will be high on the island and on subs, close to the conning tower.

It should be kept in mind that Mark 2, Model 2, with modifications or attachments, may be used either for surface search or surface fire control. It is believed that the fire control function requires three horns. The Mark 2, Model 2 set is known as a "micro-wave" Radar, designed for sensitive readings and accurate plotting of surface craft and not for great range.

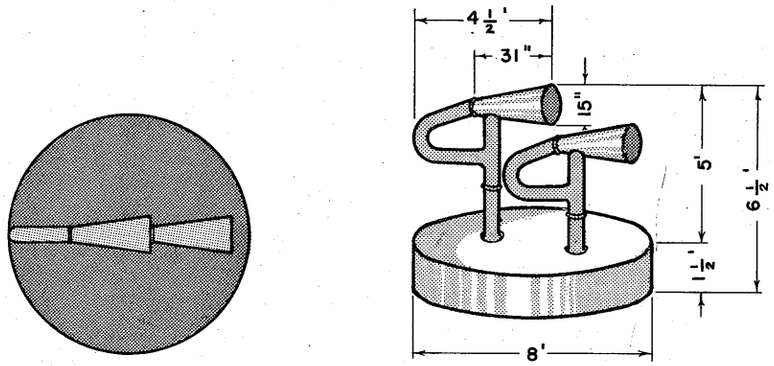
All information on this page is taken from P.O.W. and captured document sources.



MATSU CLASS DD



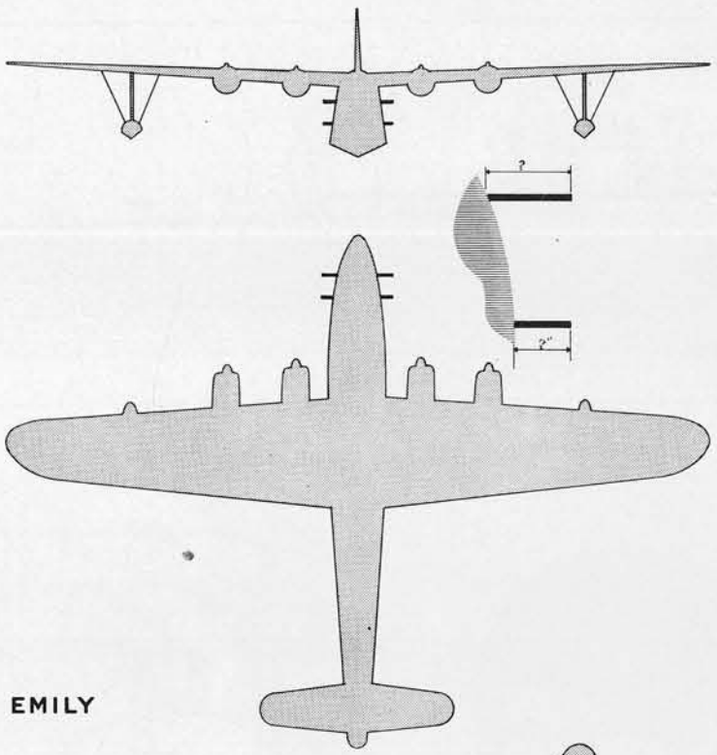
MARK 2, MODEL 2, MODIFICATION 2



MARK 2, MODEL 2

LOCATION	SHIPBORNE
TYPE (MK. 2, MODEL 2 & MODIFICATIONS)	"HORN TYPES"
ANTENNA	ELECTROMAGNETIC HORNS
FREQUENCY	3000 MCS
P.R.F. 2500 PULSE	6
MAXIMUM RANGE	25 N. MI.

RADAR
AIR BORNE TYPES



EMILY

EMILY, large Japanese Patrol Bomber, has a linear array in the forward part of the hull.

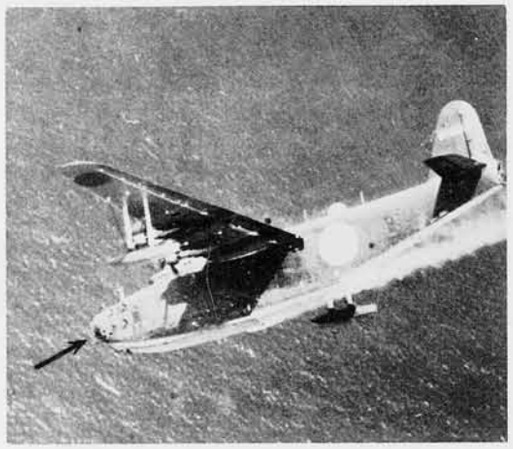
All plane types probably contain the same Radar equipment, designated as "Mark VI, Model 4", and operating at 150 mcs., with range of approximately 75 nautical miles.

Japanese Airborne Radar antennae can often be detected from aerial photographs. The Japanese probably have but one airborne model in wide use at present (MARK VI, MODEL 4), but a variety of types and locations of antennae are used. This is a search Radar.

Antennae may be a Yagi, dipole, or linear array, and may be located in the nose, leading edge of wing, or side of fuselage.

Undoubtedly, several other types will be forthcoming soon, particularly for use in night fighters.

BETTY, Japanese Medium Bomber, was the first to use Airborne Radar. The antennae consists of a nose Yagi and a small "H" shaped arrangement on the side of the fuselage.



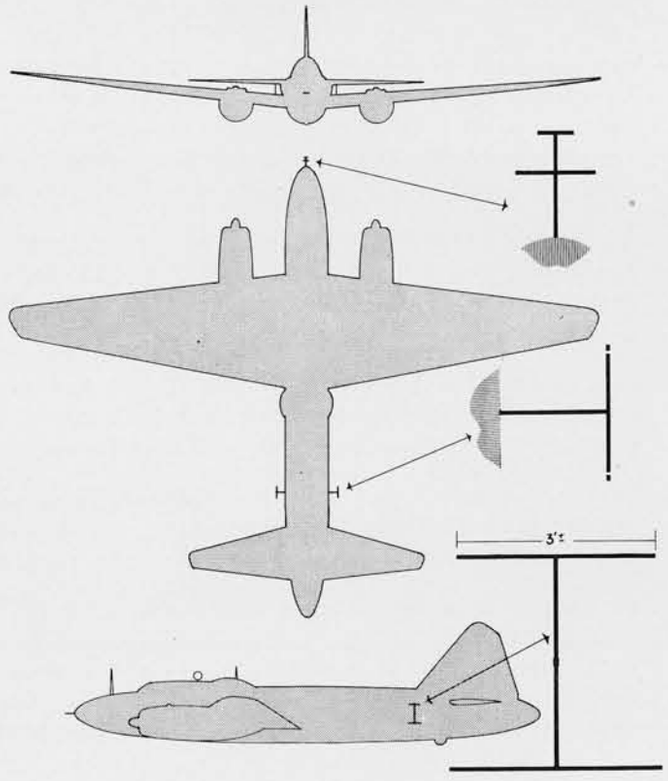
EMILY

LOCATION . . . . . EMILY
TYPE . (AIR MK. 6, MODEL 4) . "AIRBORNE"
ANTENNA . . . . . LINEAR ARRAY
FREQUENCY . . . . . 150 MCS
P.R.F. . . 1000 . . . PULSE 5
MAXIMUM RANGE . . . . . 55 N. MI.?

EMILY

BETTY

LOCATION . . . . . BETTY
TYPE . .(AIR-MK. 6, MODEL 4). "AIRBORNE"
ANTENNA . . . . . NOSE YAGI & "H" ARRAY
FREQUENCY . . . . . 150 MCS
P.R.F. . . 1000 . . . PULSE 5
MAXIMUM RANGE . . . . . 55 N. MI.?



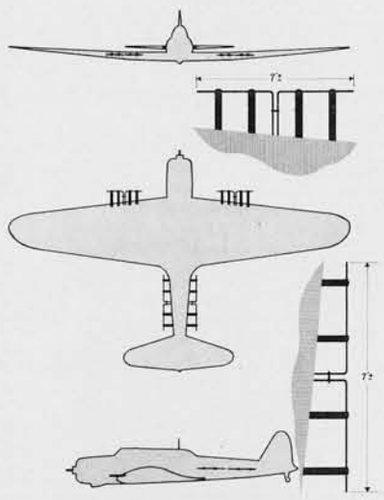
BETTY

RADAR

AIR BORNE TYPES (CONT.)

KATE, Japanese Torpedo Bomber, has been fitted with dipole antennae. There are two 5 foot dipoles on the leading edge of the wings, and two 8 foot dipoles on the sides of the fuselage. Antennae on JUDY is reported to be the same design as KATE.

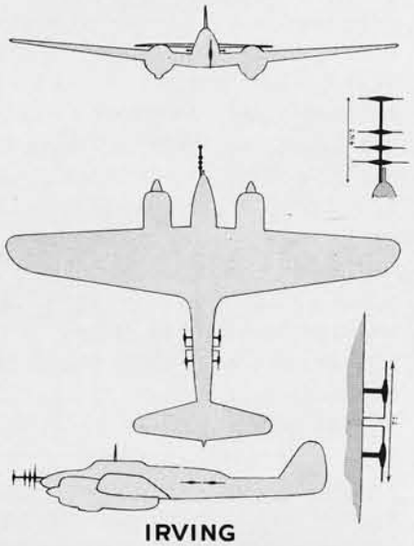
LOCATION	KATE & JUDY
TYPE . . . (AIR MK. 6, MODEL 4)	"AIRBORNE"
ANTENNA	DIPOLES
FREQUENCY	150 MCS
P.R.F. . . . 1000 . . . . . PULSE	5
MAXIMUM RANGE	55 N. MI. ?



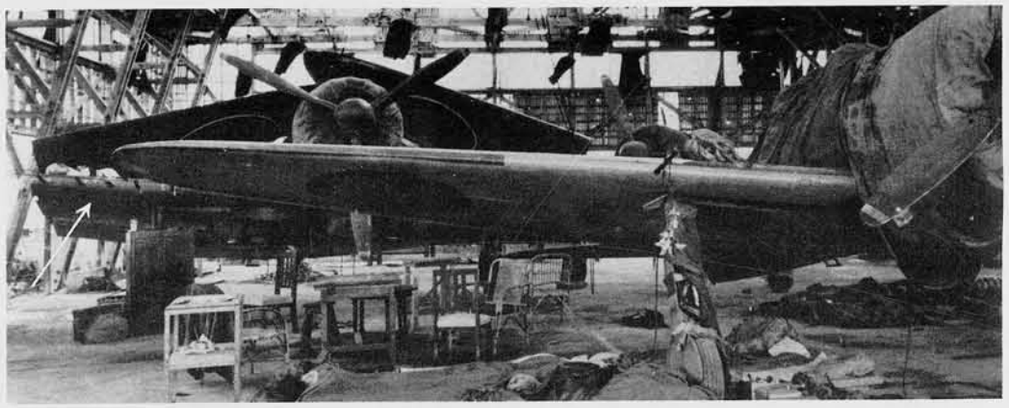
KATE

IRVING, Japanese Reconnaissance and Night Fighter plane is equipped with Yagi dipoles in the nose (similar to German designs) and a 6 foot dipole on either side of the fuselage. All dipoles are set in heavy insulators, which can be seen in fairly small photography.

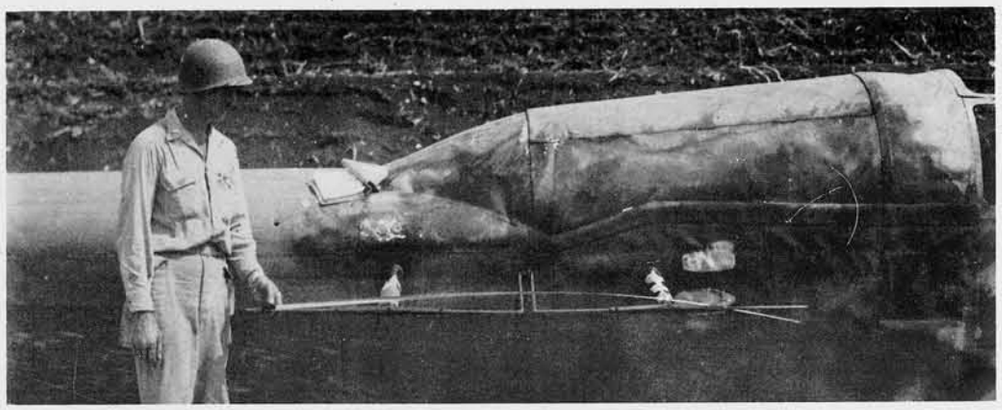
LOCATION	IRVING
TYPE . . (AIR MK. 6, MODEL 4)	"AIRBORNE"
ANTENNA	NOSE YAGI & DIPOLES
FREQUENCY	150 MCS
P.R.F. . . . . 1000 . . . . . PULSE	5
MAXIMUM RANGE	55 N. MI. ?



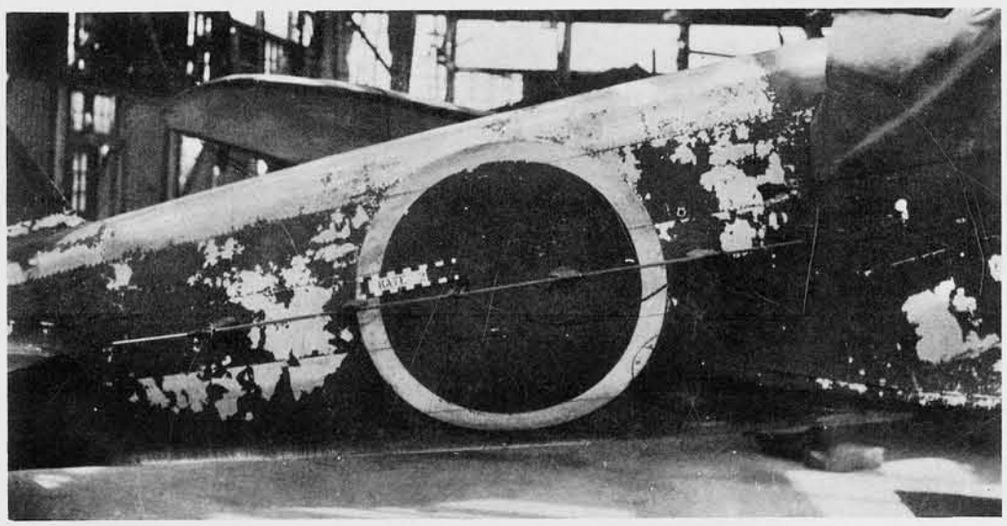
IRVING



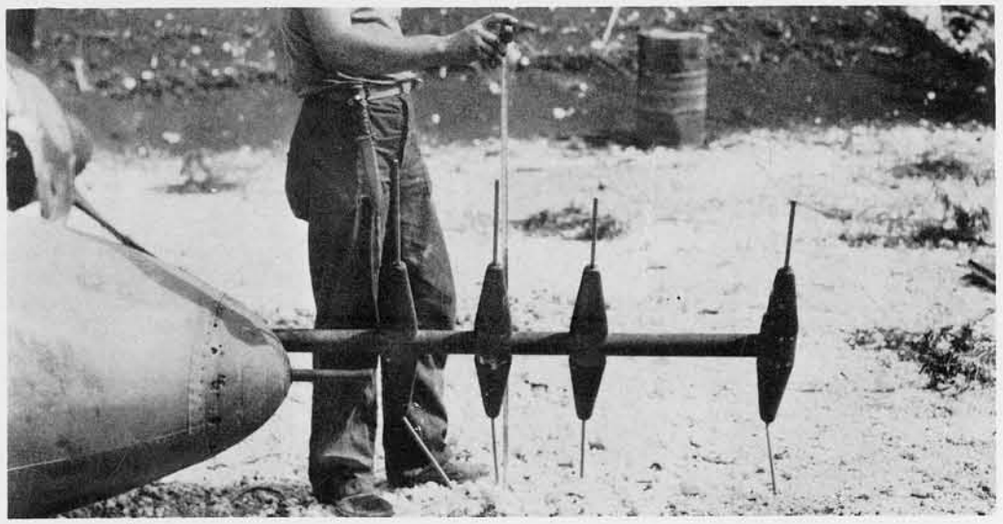
KATE



IRVING



KATE



IRVING

RADAR

FIRE CONTROL (MK. IV, MOD. 3)

Japanese land-based Fire Control Radar is now coming into general use. Although information is sketchy and incomplete as to the types that may be most used, facts and pictures which are now available are shown and discussed on these pages. At this time there are apparently three basic trends in Japanese Fire and Searchlight Control Radar:

(1) Models based on British "SLC" (Yagi antennae mounted on a searchlight, which was probably captured on Singapore).

(2) Models based on the United States SCR268, probably captured on the Philippines.

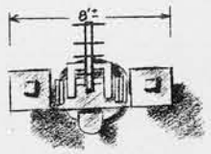
(3) Models based on British GL, Mark 2, which uses separated transmitter and receiver installations with elaborate arrays.

In addition to these general types, the possibility of the Japanese developing a copy of the German Wurzburg for land-based fire control must be kept in mind.

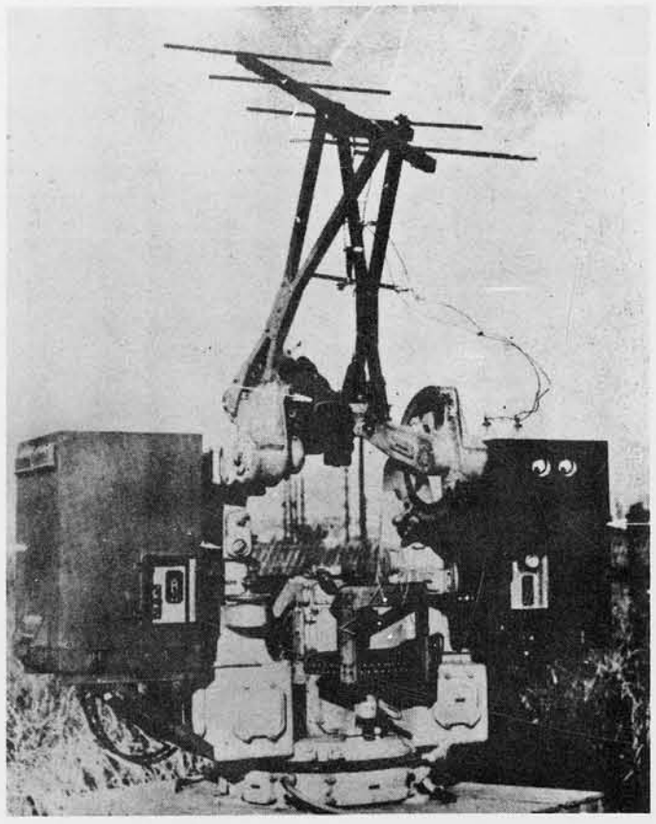
The Japanese designation of the installation shown on this page is "Mark IV, Model 3". It is a 200 mcs Radar consisting of two parts: (1) The Transmitter (mounted on a searchlight controller), which supports one row of Yagi antennae on an elevated cross arm. The whole mount, including antenna and operator's seat, rotates, and the antenna tips up and down. Radar equipment is on either side of the operator.

(2) The Receiving antenna, consisting of 4 Yagis mounted on a type 96 110 cm. searchlight. (See below, right.) It is lobe switched at 25 per second. Note that searchlight shown here is mounted on a hut.

The pictures shown here are of the first fire control equipment captured in the Pacific war, and indicate an adaptation of the British S. L. C. In these examples, it will be noted that the transmitting and receiving antennae were on separate mounts at separate locations.

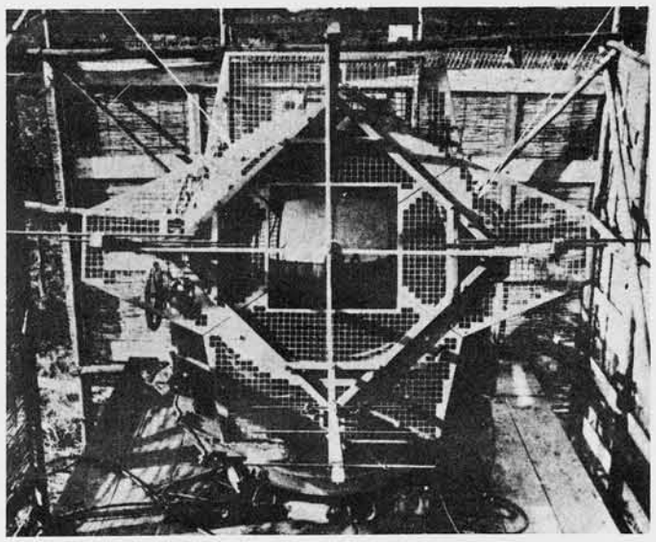


LOCATION . . . . . MARIANAS
TYPE . . . . . MARK IV, MODEL 3
ANTENNA . . . . . YAGI S
FREQUENCY . . . . . 200 MCS
P.R.F. . . 2000 . . . . PULSE . . . . . 3 - 5
ACCURACY. RANGE - 100 YDS., BEARING - 1°, ELEV - 1°

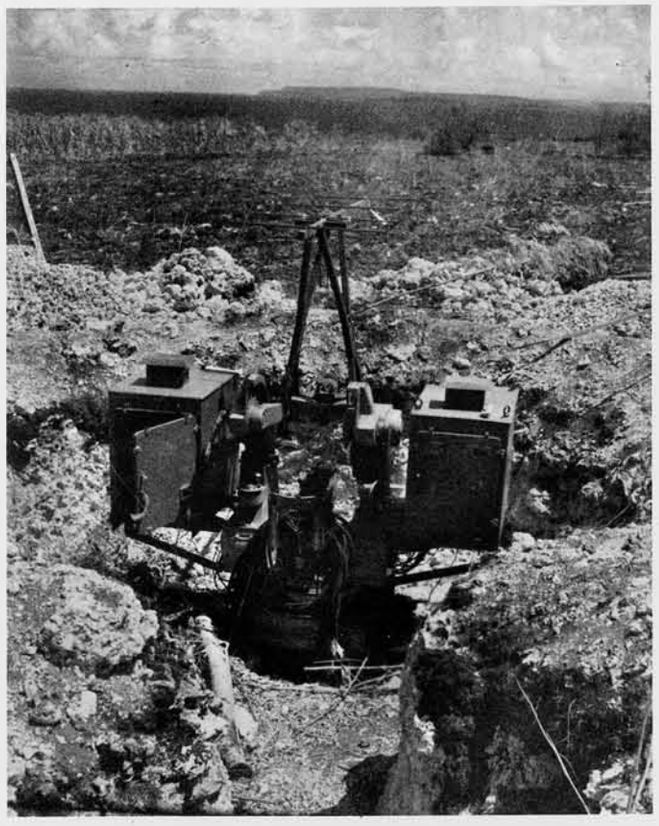


TRANSMITTING ANTENNA

The pictures shown on this page are of the first captured equipment in the Pacific war, and indicate an attempt was made to copy the British S. L. C.



RECEIVING ANTENNA



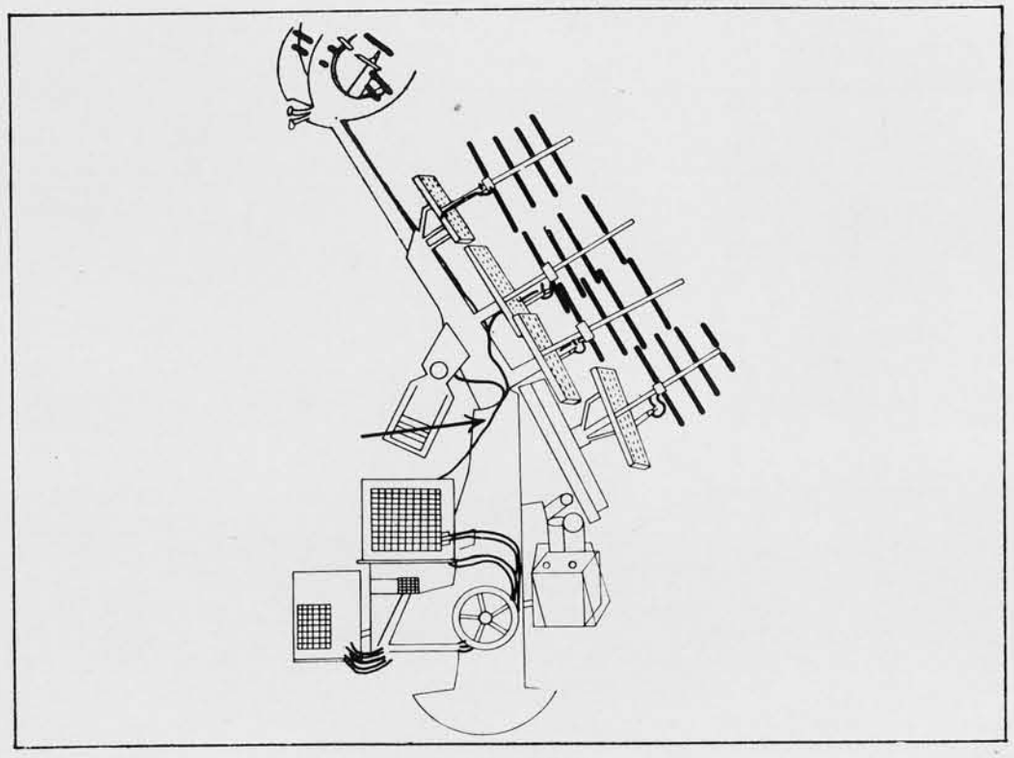
TRANSMITTING ANTENNA

In these examples, it will be noted that the transmitting and receiving antennae were on separate mounts at separate locations.

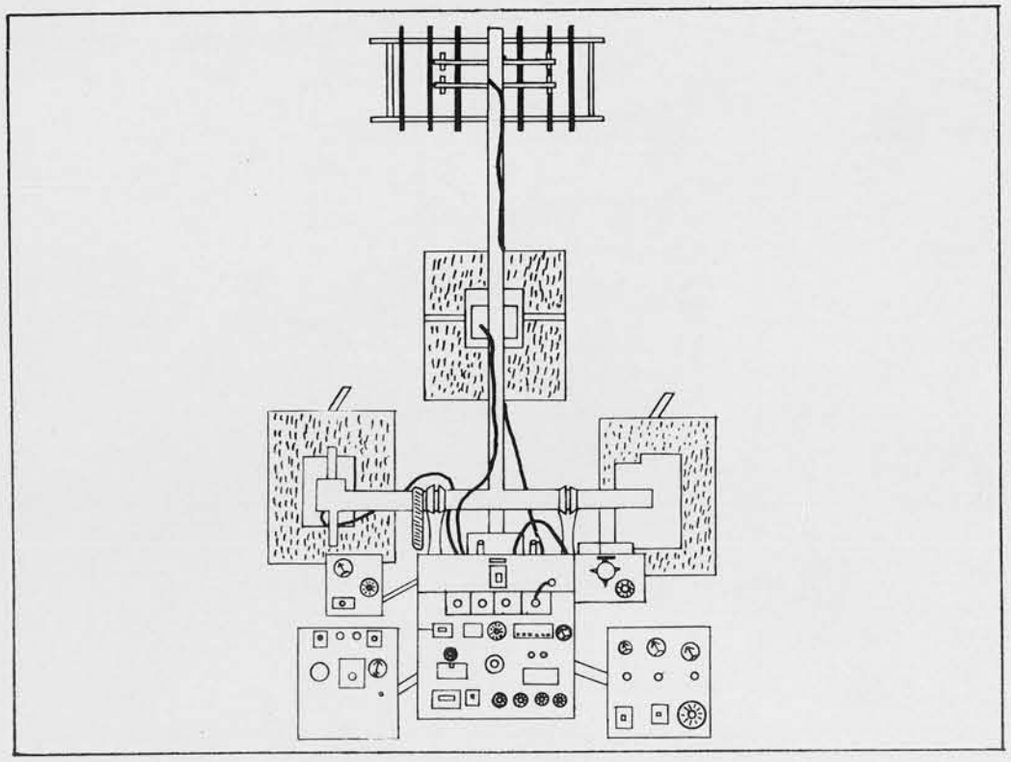
TRANSMITTER MOUNT

RADAR

(MK. TA., MOD. 1) FIRE CONTROL



SIDE VIEW



FRONT VIEW

It is thought that the Mark "TA", Model 1 A/A Fire Control Radar operates in a similar manner, basically, to the Mark IV, Model 3 which is shown on the previous page.

However, in this case, the transmitting antenna is mounted above the four receiving Yagis, on the same piece of equipment. Also, the mount is believed to be of special design and not a searchlight or searchlight controller. The frequency of this set is 200 mcs. as are most of the Japanese Fire Control Radars at this stage of development.

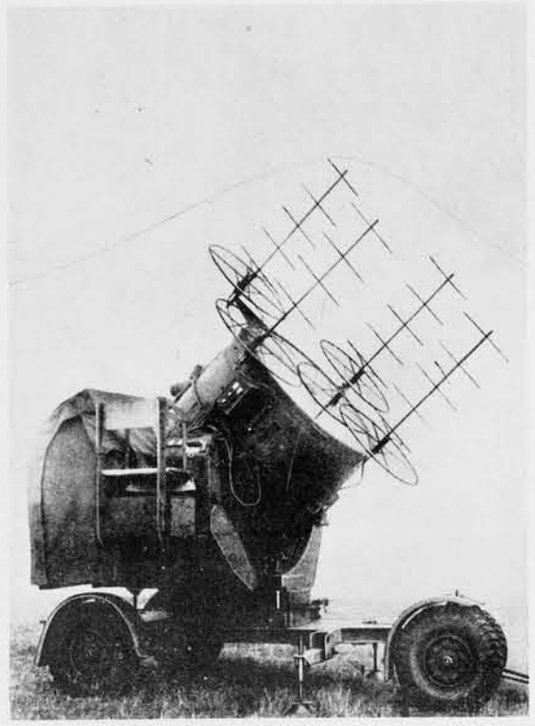
Most of the information on this page was taken from notes and sketches of a Japanese non-commissioned officer, which were made during training. The sketches leave much to be desired in clarity of drawing. Nevertheless, a rough estimate of size yields the following dimensions: front view 8 - 10 feet wide; side view 12 - 15 feet high. The whole installation rotates, and the vertical shaft appears to tip back at point A.

LOCATION	A/A OR S/L
TYPE	MARK "TA", MODEL 1
ANTENNA	YAGI S
FREQUENCY	200 MCS
P.R.F.	PULSE . . . 3

Captured documents have referred to a Mark "TA", Model 2, Fire and Searchlight Control Radar, but very little is known about this set except for the following data: Frequency - 200 Mc., PRF - 1000 Cps., Pulse - 2 microseconds, Range accuracy - 100 yards. It is listed as being designed for A/A Fire Control and Air Warning.

The antennae (5 YAGI S) are thought to be mounted on a searchlight in a manner similar to the British S.L.C., in which case both the transmitting and receiving antennae are mounted together. This is in contrast to the separated design of the Mark IV, Model 3.

A photo of the British S.L.C. (A/A, No. 2, Mark VI) is shown here for reference.



BRITISH S.L.C. (A/A, NO. 2, MK 6)

RADAR

FIRE CONTROL (MK. TA., MOD. 3)

The Mark "TA", Model 3 Fire Control Radar is believed to be radically different from Model 1 and 2 of the "TA" series.

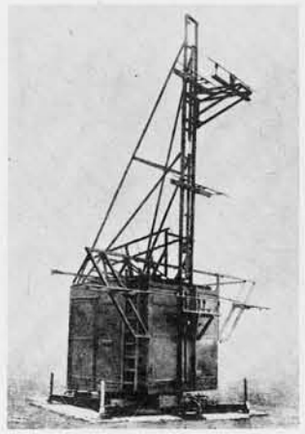
The prototype of this set is probably the British GL Mark 2 which was captured in Malaya.

Most of the present information on this Radar is taken from a captured notebook which was translated and analyzed by Gen. Hq., S.W.P.A.

This model is a Low Frequency (75 mcs.) Fire Control Radar which uses a transmitter with a five element Sterba array set close to the ground with a single dipole 20 feet above and a separated receiver which has 6 dispersed dipoles. There may be 80 to 150 feet separation between transmitting and receiving equipment.

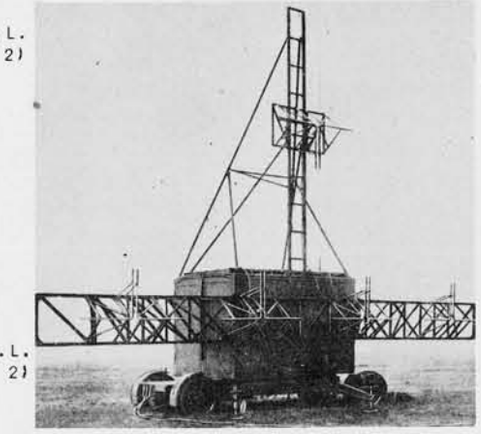
A feature of this set which should be of distinct interest to interpreters is the fact that it requires an extensive cleared area around the transmitter, and it is thought by some that a slight (swale-like) depression provides the best siting for its functions as a Fire Control Radar. At any rate, the ground must be clear of trees for a radius of 200 feet or more and should be accurately graded close to the receiver.

Sketches of the probable appearance of the Japanese Transmitter and Receiver as indicated from captured document sources, are shown here, as well as ground photos of the original British equipment from which they are believed to have been copied or adapted.

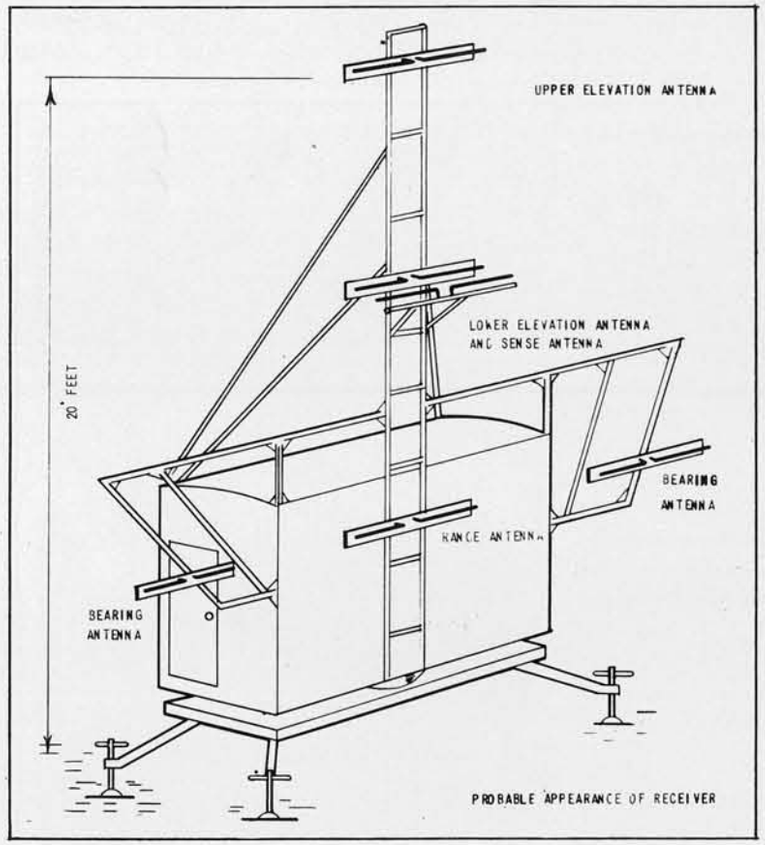


LEFT: BRITISH G.L. (A A, NO. 1, MK. 2) RECEIVER.

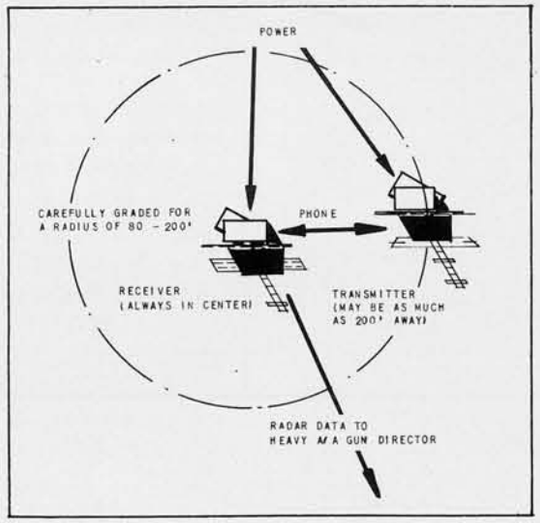
RIGHT: BRITISH G.L. (A/A, NO. 1, MK. 2) TRANSMITTER.



LOCATION	A/A OR S/L
TYPE	MARK "TA", MODEL 3
ANTENNA	STERBA ARRAY & DIPOLES
FREQUENCY	75 MCS
P.R.F.	1000-2000 PULSE 1 - 2
ACCURACY	RANGE - 25 YDS., BEARING - 0.5°, ELEVATION - 1°

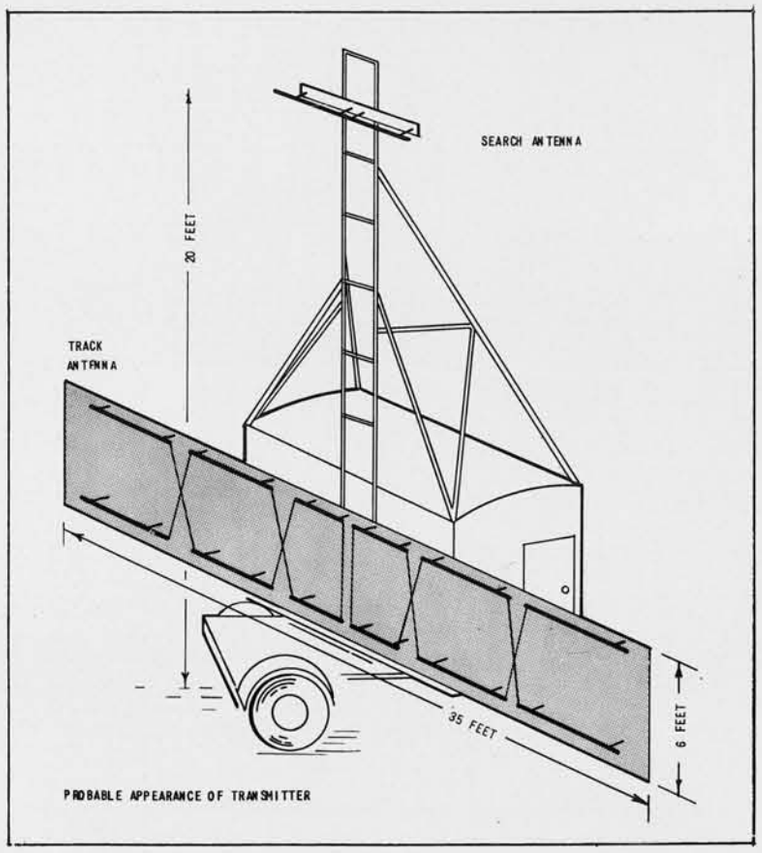


RECEIVER



HYPOTHETICAL PLAN

The above sketch represents an hypothetical arrangement of the Mark "TA", Model 3, as seen in plan view. However, the circular clearing and graded area may vary considerable in size. Ground mats may be used instead of clearing and grading.



TRANSMITTER

ATTU type Japanese radar, captured at TARAWA in the GILBERTS. This ATTU type radar was in an unassembled state when first found at ATTU, ALEUTIANS. Electrically very similar to the GUADALCANAL type radar, but representing an improved modification. Note the horizonta ly elongated box-like shape of the screen which forms the most important identification factor. Spotting of radar positions in aerial photos is largely dependent on screens and screen shadows.

At BITITU Island, TARAWA Atoll were two ATTU type radars of identical design. One was at the west end and the other a few hundred feet from the east tip. Both were set on high concrete bases and were used for different sectors of the air and surface search.

LOCATION	TARAWA
TYPE.....(MARK I, MODEL I, MODIF. I)	ATTU
ANTENNA	28' x 14' x 2' 4"
FREQUENCY	100 MCS
P.R.F.....880 - 1200.....PULSE.	12 - 30
MAXIMUN RANGE	75 N. MI.

MOBILE MATTRESS, or MARK I, MODEL II. This radar operated at 200 mcs. and is identified by a small screen (14' x 7') mounted on a Japanese standard army trailer (type 94). This radar was used for land-based search, either alone or in conjunction with older types. The shack, antenna, revolving mount and trailer could be separated for shipping purposes.

MARK 6 PORTABLE. This is an adaptation of the same set used in aircraft for search (Mark 6, Model 4). This set was found on GUAM. Antenna consists of dipoles. Frequency...150 mcs. Maximum range about 30 N. MI.

LIMBER FREYA WITH I.F.F. This is one of the earliest types of German equipment, developed for air search or early warning. Practical range was 75 Naut. miles. The high blast wall was a characteristic of Freya installations.

SMALL WURZBURG on BOWLFIRE was first designed in 1936 and was one of the most efficient German radars. It was used primarily for A. A. fire control but was a standby for Ground Control of Acft, Acft reporting and Searchlight Control. In general was a mobile radar, mounted on a four-wheeled trailer with out-riggers for levelling.

GIANT WURZBURG - 3/4 VIEW.....This was a fixed, non-mobile radar for measuring range, bearing and height of target Acft. Principal use was for Ground Control Intercept. Practical range---40 N. MI.

RADAR

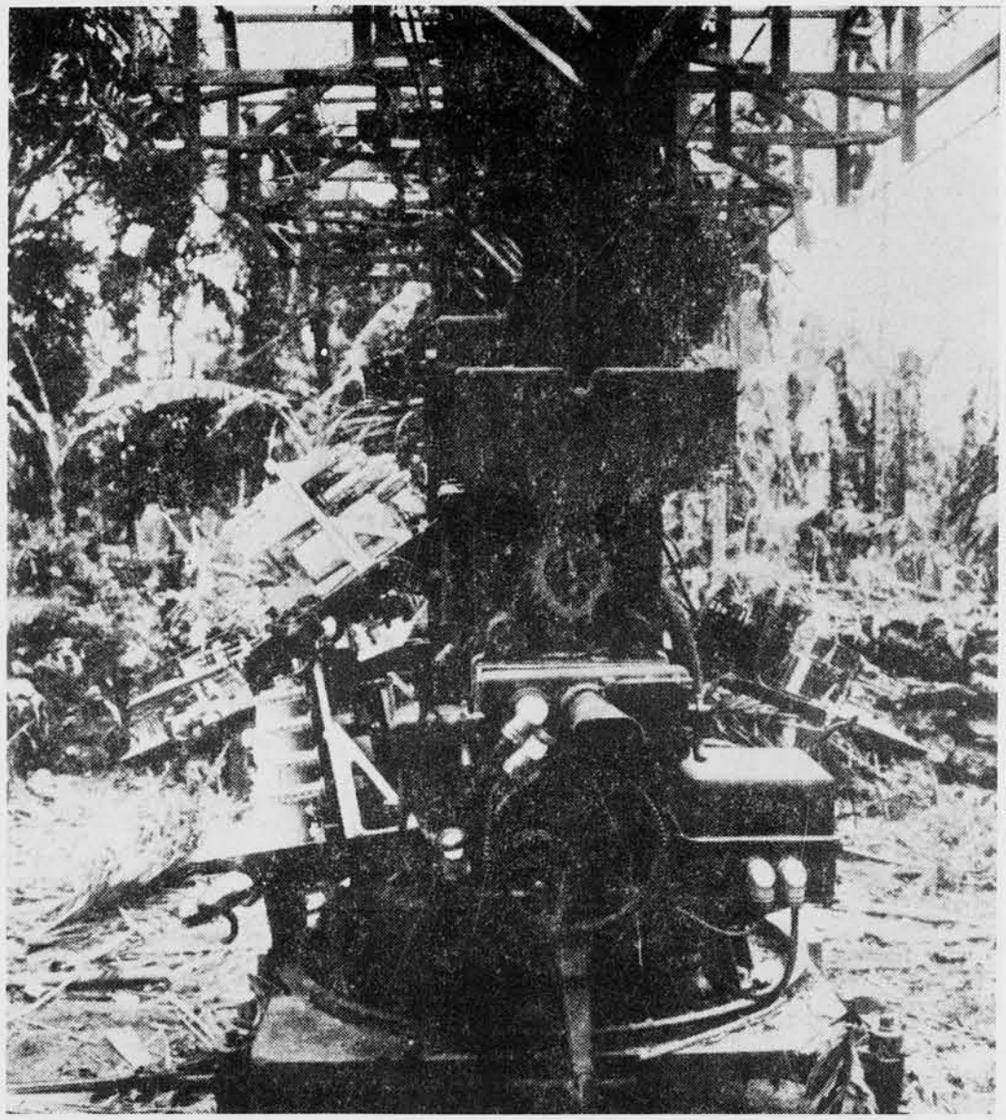
(MK. IV, MOD.I) FIRE CONTROL

The Japanese adaptation of our SCR 268 Fire Control Radar was first captured on Peleliu and is believed to be the same set referred to in captured documents as "Mark IV, Model I," and sometimes as "S-3".
The Mark IV, Model I (shown on this page) is a Fire Control Radar which operates at a frequency of 200 mcs. This set is not well adapted to mass production for wide use. Captured documents refer to a "Mark IV, Model 2" and a "Mark IV, Model 2, Modification 2" which may indicate that future use of a smaller improved model or models of this Radar, designed for mass production, can be expected.

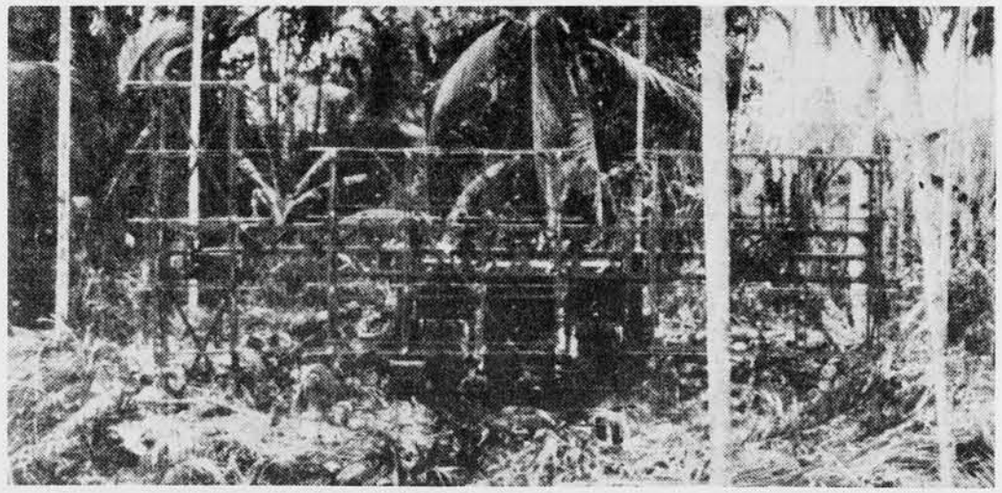
The "Mark IV, Model I" type(or types)will function better when sited in a cleared graded area.

There are three antenna bays mounted on a 25 3/4-foot long horizontal beam which in turn is mounted on top of the large frame which supports all the various units of the radar. The beam is about 9 feet above ground base. All antenna elements reflectors, radiators, and directors are lengths of 1/4 inch copper tubing mounted by means of ceramic insulators on wooden frames which are fastened to the cross beam.

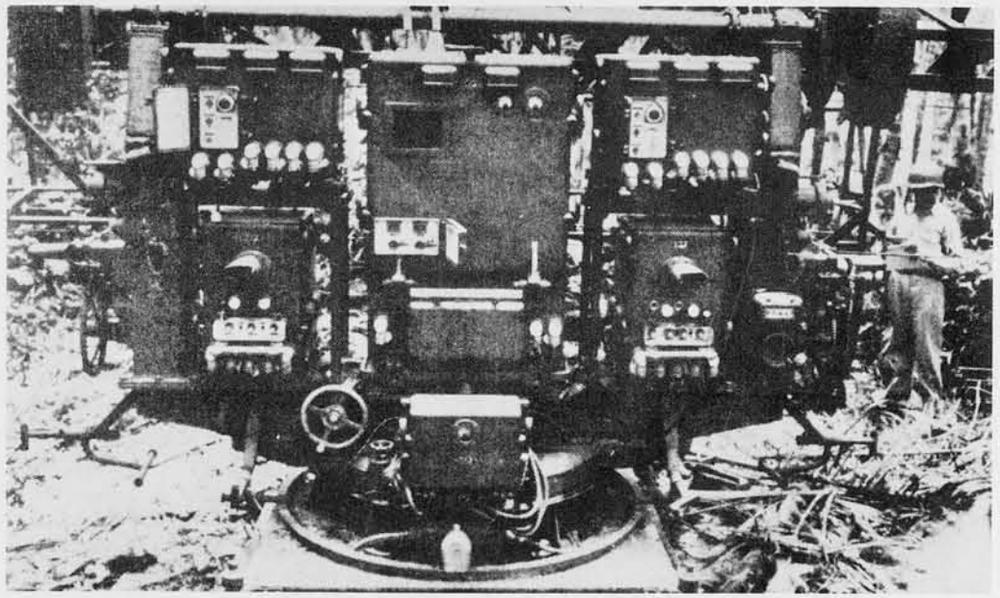
LOCATION	PELELIU
TYPE	MARK IV, MODEL I
ANTENNA	25 3/4' x 6' x 4' MATTRESS
FREQUENCY	200 MCS
P.R.F.	2000 PULSE .3 - 5
ACCURACY	RANGE - 50 YDS. BEARING - 0.5° ELEVATION - 0.5°



SIDE VIEW



FRONT VIEW



DETAIL OF BASE

RADAR

SUPPLEMENTARY MATERIAL (FIRE CONTROL)

FIRE AND SEARCHLIGHT CONTROL RADAR

Here, under the heading, "Supplementary Material", is shown a collection of stereograms of interest to the photographic interpreter when checking on new patterns in aerial photographs which suggest Fire Control Radar.

Conservatively, all of the installations should be referred to as being "suspicious" if not "probable". However, it must be borne in mind that none have been positively identified.

To review the Fire Control Radar situation at the close of 1944, the following trends and types are believed to be in use or in production:

British "SL" Types	British "GL" Types	United States SCR 268 Types
1. Mark IV, Model 3	1. Mark "TA", Model 3	1. Mark IV, Model 1 (S-3)
2. Mark "TA", Model 1		2. Mark IV, Model 2
3. Mark "TA", Model 2		3. Mark IV, Model 2, Mod. 2

In addition to those listed above, the German Wurzburg should be watched for, as well as other Japanese types which have been reported, but on which little information is available at this time.

Fire Control Radar interpretation is also a part of gun interpretation, and an understanding of the equipment and functions of anti-aircraft fire control centers and guns is helpful to identification. (See P.I.C. Publication #3: "Japanese Anti-aircraft and Coastal Defense Guns")

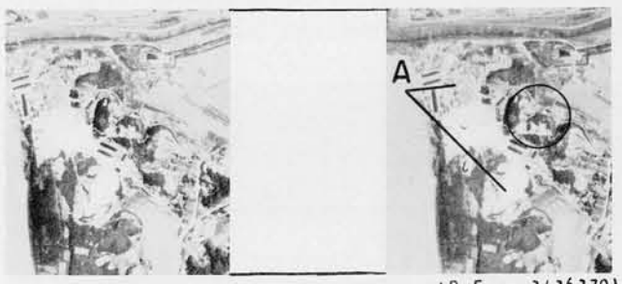
Certain specific forms and patterns have been observed repeatedly in pictures taken over Japanese-controlled territory, which have created suspicions as to the presence of Fire Control Radar. In each case the forms in question are found close to heavy A/A and are sited fairly well for the functions of Fire Control Radar. It is believed, further, that such forms and patterns do not represent other known functions of A/A fire control such as directors, visual range finders, sound locators, searchlights, etc.

In general, these forms and patterns may be classified as follows:

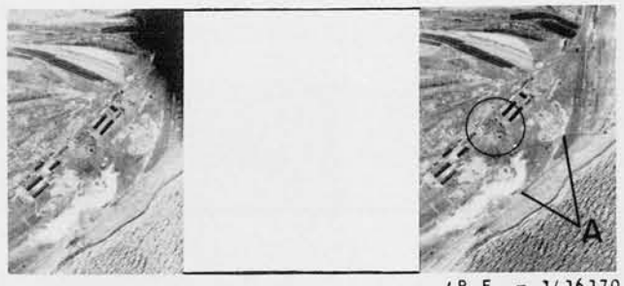
1. A circular cleared area, often with a saucer-shaped depression, with a diameter of from 150' to 200'.
2. A 22' diameter cylindrical form, about 10' high (possibly with a conical roof) out of the center of which extends a vertical shaft supporting a cross-arm (antennae ?). The whole is frequently enclosed in a low revetment of 50' diameter.
3. A small circular revetment, enclosing "something", from which a buried cable is observed running to the fire control center (to the director ?) and thence to the heavy A/A guns.

It must be borne in mind that A/A Fire Control Radar need not be sited on the highest point of land, but often will be found in low flat areas, wide valleys, and frequently on the same level or lower than the heavy A/A guns.

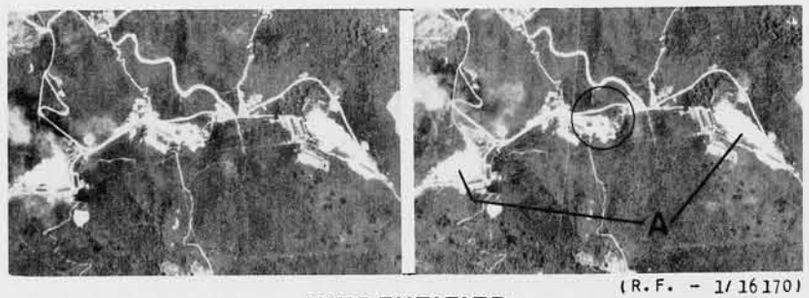
When searchlight revetments are found accompanied by another circular revetment, and not in the immediate vicinity of heavy A/A batteries, the extra revetment is likely to contain either Searchlight Control Radar or a Sound Locator.



UNIDENTIFIED (R.F. - 1/16170)



UNIDENTIFIED (R.F. - 1/16170)



UNIDENTIFIED (R.F. - 1/16170)

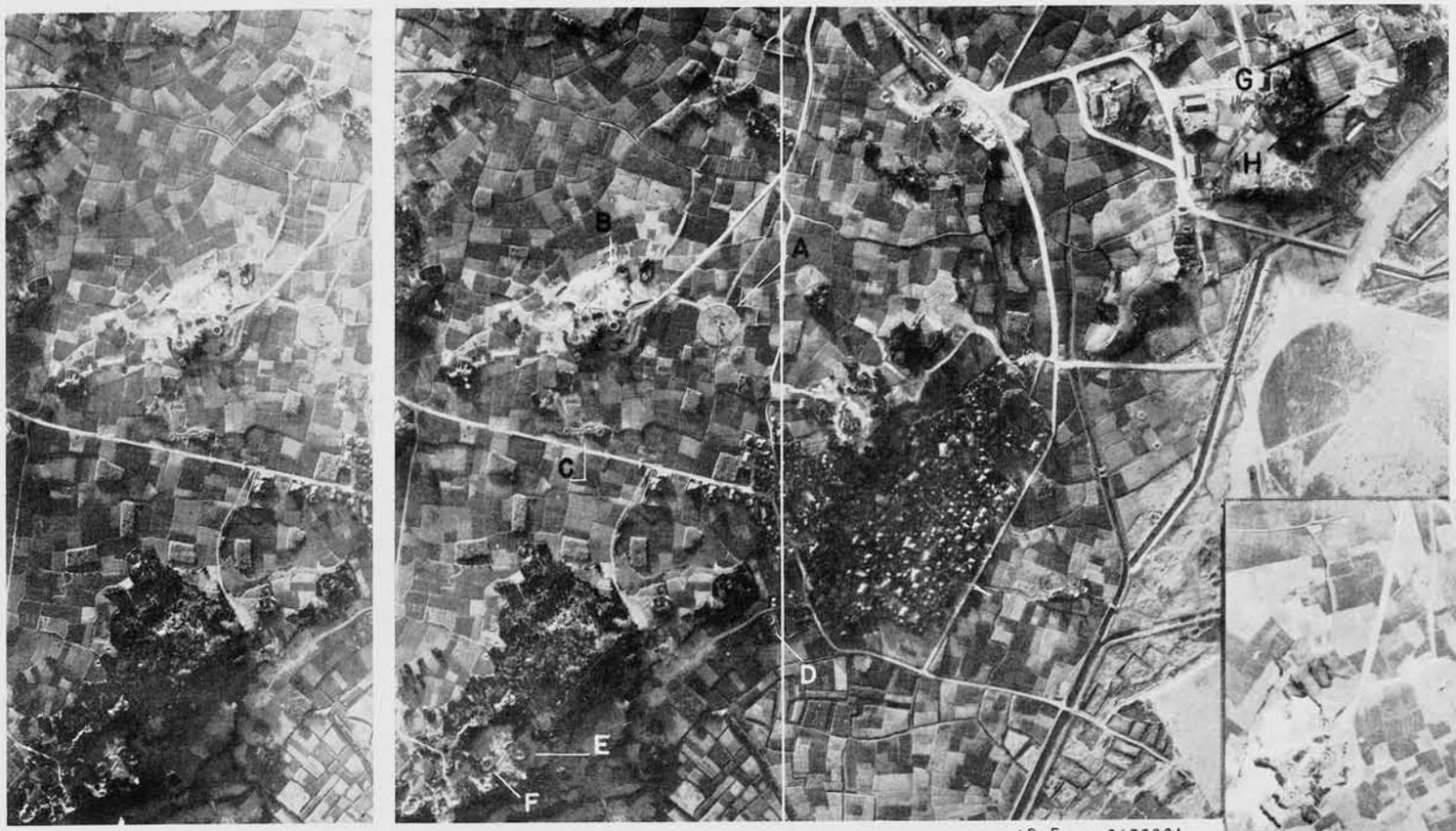
ABOVE:
The cylindrical form is similar in shape and dimensions to the standard concrete water cistern, i.e., 20-22 feet in diameter and approximately 10 to 12 feet in height. The revetment is about 50 feet inside diameter. A definite shadow, presumably from a horizontal cross arm erected on top of this structure, looks very much like antennae and causes speculation on the possibilities of the installation enclosing Fire Control Radar. Each of these installations is in association with two 6-gun heavy A/A batteries marked "A".

RIGHT: One of the numerous types of circular clearings seen recently. This particular one on Honshu contains Mark "TA", Model 3 Fire Control Radar.

PROBABLE MK. "TA", MOD.3 (R.F. - 1/17000±)

RADAR

SUPPLEMENTARY MATERIAL (FIRE CONTROL)



PROBABLE MK. IV, MOD. I

(R.F. - 1/7500)

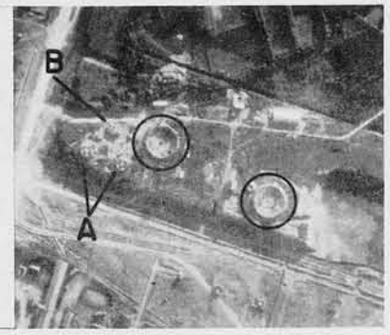
"A" - Probably Fire Control Radar. "B" - 4-Gun 120 mm. AA Battery (Also construction activity). "C" - 25 mm. AA Guns. "D" - Device For Processing Sugar Cane or Rice. "E" - Searchlight (150 cm.?). "F" - Sound Locator. "G" - Probable Searchlight (110 cm.?). "H" - Unidentified Construction, possibly S/L Control Radar.

The installation at "A" although not conclusively identified, is believed to be the "Mark IV, Model 1, S-3" Fire Control Radar, an adaption of United States type SCR 268. It is mounted in the center of a 150' diameter circle having a concave cross section resembling a saucer shape.

Note the presence of a drainage ditch leading out from the center of the circle. An underground entrance and a low guyed stick mast are also present. Radar is 550 feet from the nearest heavy AA gun emplacement ("B").

(R.F. - 1/5500)

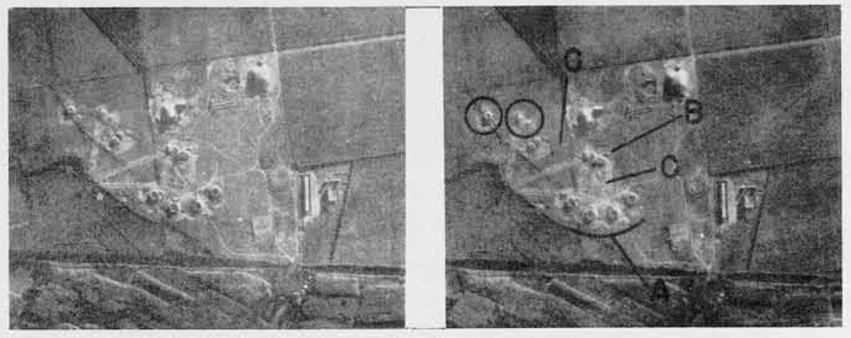
PROBABLE MK. IV, MOD. I



UNIDENTIFIED

"A" - HEAVY A/A GUNS (127 MM?) "B" - FIRE CONTROL CENTER

Encircled forms are saucer-shaped and are 150 feet in diameter. The sides of the saucer are built up above grade. The lowest part of the saucer is probably on grade or slightly below. A shadow from a vertical shaft is seen in the left emplacement.



SUSPECTED MARK IV. MODEL 3

"A" - HEAVY A/A BATTERY "B" - FIRE CONTROL CENTER "C" - BURIED CABLE

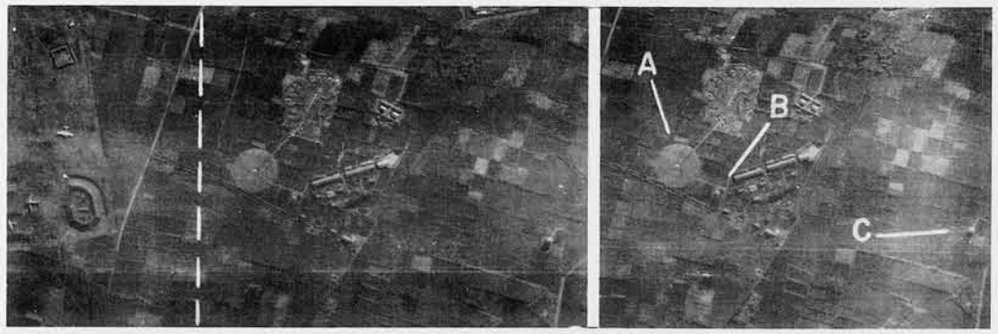
The encircled emplacements above are believed to contain Fire Control Radar equipment, possibly Mk. IV, Mod. 3. (If only one emplacement is in use, Mk. "TA", Mod. 1 or 2 would be likely.) Note underground cable leading to Fire Control Center, a distance of 550', and thence to each heavy A/A gun position.

RADAR

SUPPLEMENTARY MATERIAL (FIRE CONTROL)

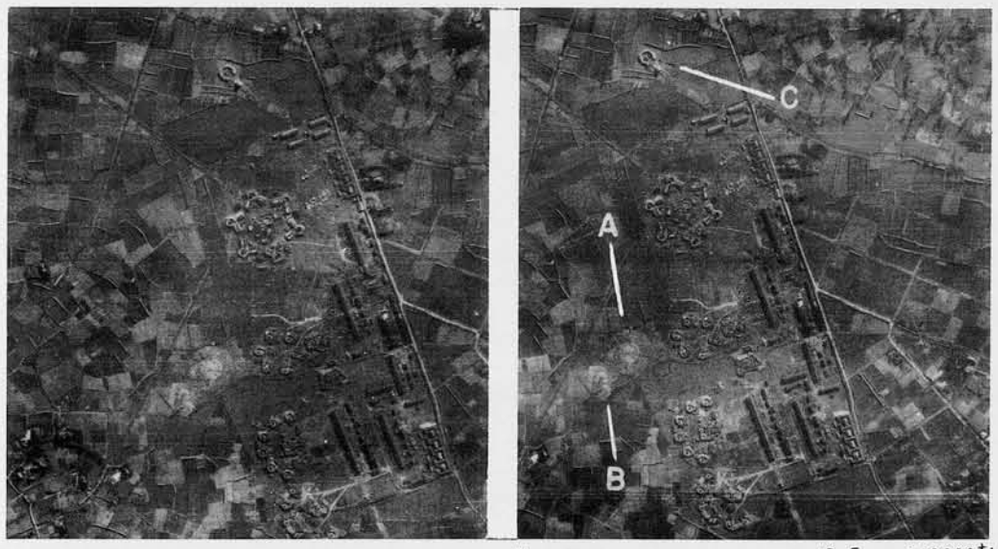
The Mark "TA", Model 3 Fire Control Radar, which is an adaptation of the British GL, Mark 2, has been the most frequently identified model up to the present, particularly on Honshu. This is partially due to the ease of recognition of this particular type. Three examples which are believed to contain Mark "TA", Model 3 are included on this page.

Two Searchlight Stations with accompanying Sound Locator revetments are included here for comparative purposes.



PROBABLE MARK "TA", MODEL 3 (R.F. - 1 9000±)

"A" - RECEIVER; "B" - TRANSMITTER; "C" - SUSPECTED D. F.



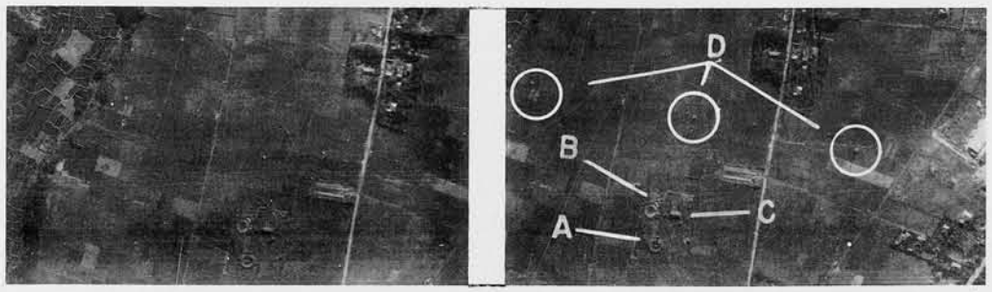
PROBABLE MARK "TA", MODEL 3 (R.F. - 1/9000±)

"A" - RECEIVER; "B" - TRANSMITTER- "C" - SEARCHLIGHT

The two stereograms shown above are good examples of Mark "TA", Model 3. Fire Control Radar set up with heavy A/A gun batteries.

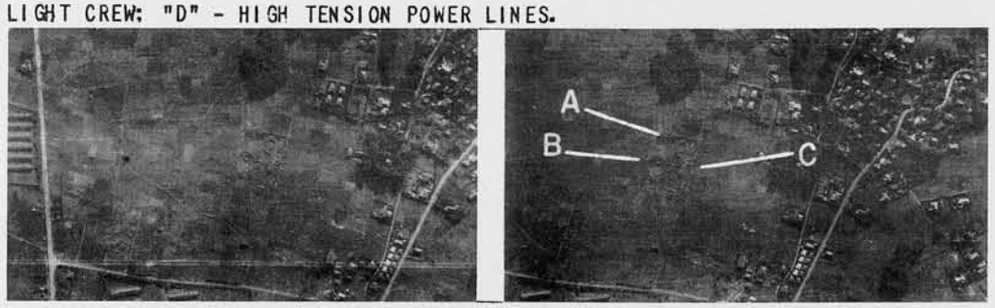
The circular clearings around the transmitter are about 200' in diameter and are carefully graded. (The inner circular clearing in lower stereogram is 100' in diameter.) Cable lines run between the transmitter and the Receiver and from the Receiver to the Director (in the Fire Control Center). Receiver is usually 500' - 600' from the Fire Control Center.

All guns shown are 75 millimeter except the hexagonal battery in lower stereogram which is probably composed of 120 millimeter guns.



SEARCHLIGHT (R.F. - 1/9000±)

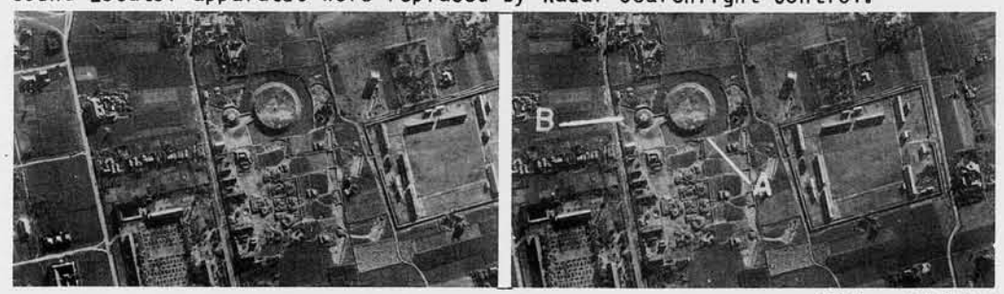
"A" - SEARCHLIGHT; "B" - SOUND LOCATOR; "C" - BARRACKS BUILDING FOR SEARCHLIGHT CREW; "D" - HIGH TENSION POWER LINES.



SEARCHLIGHT (R.F. - 1/9000±)

"A" - SEARCHLIGHT; "B" - SOUND LOCATOR; "C" - BARRACKS BUILDING FOR SEARCHLIGHT CREW.

The two stereograms shown above are of Searchlight Stations with Sound Locator control. These are included for comparison with Radar Fire Control emplacements. Although these are fairly typical examples of Sound Locator revetments, it would be difficult to ascertain, at this scale, if the Sound Locator apparatus were replaced by Radar Searchlight Control.



SUSPECTED MARK "TA", MODEL 3 (R.F. - 1/9000)

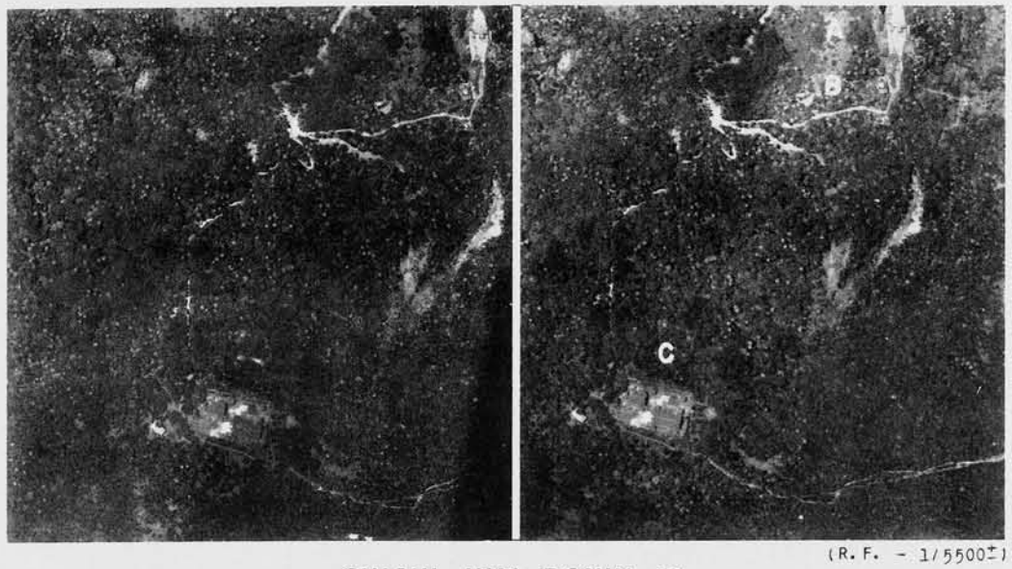
"A" - RECEIVER; "B" - TRANSMITTER.

In this stereo, the form that resembles a buried fuel tank is apparently surmounted by a Mark "TA", Model 3 Receiver. The A/A battery appears to be composed of 75 mm. guns. This is a smaller group of guns than is usually found with Radar Fire Control of this type.

Several other examples of Mark "TA", Model 3 have been found recently (in addition to those shown in this book). At the present time, it has been identified more frequently than any other type - but this may be partially due to the fact that it offers the most obvious identifying characteristics.

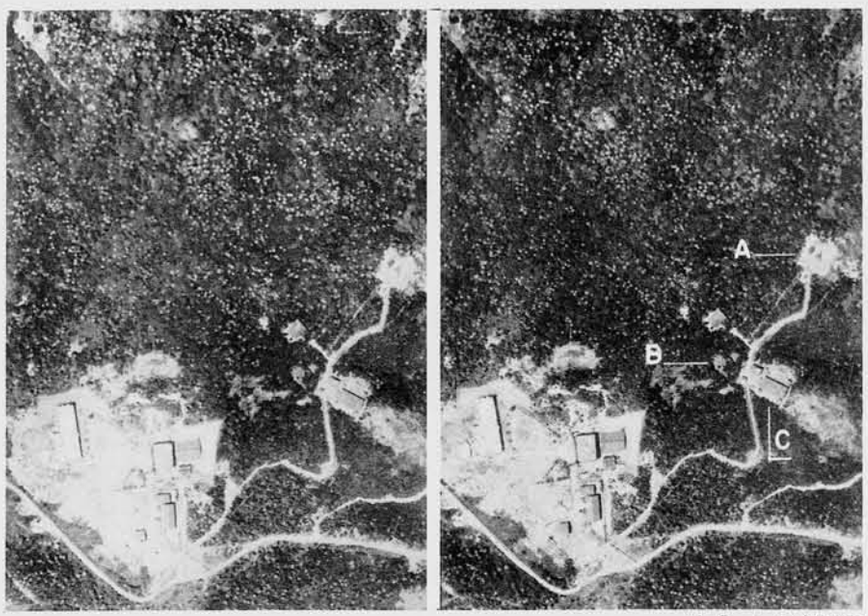
RADAR

SUPPLEMENTARY MATERIAL (SEARCH)



(R.F. - 1/5500±)

CHICHI JIMA, BONIN IS.



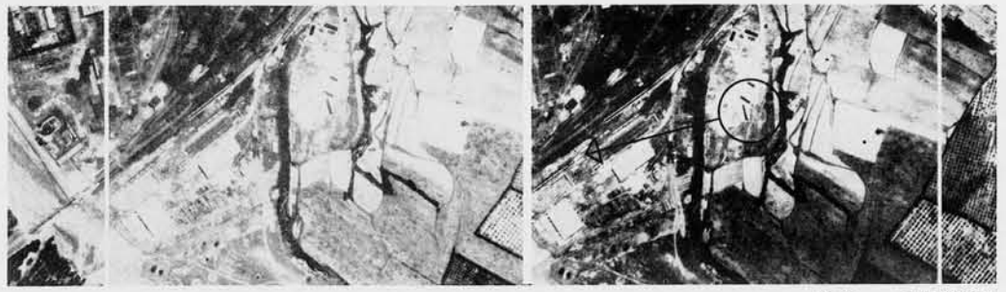
(R.F. - 1/6000±)

CHICHI JIMA, BONIN IS.

Two radar sites on Chichi Jima show a standardization of associated structures which may prove helpful for interpretation at scales too small to clearly identify the Radar itself.

"A" - MARK I, MODEL I RADAR.
"B" - OBSERVATION PLATFORM ON TOP OF BUILDING.
"C" - PROBABLE BARRACKS BUILDING.

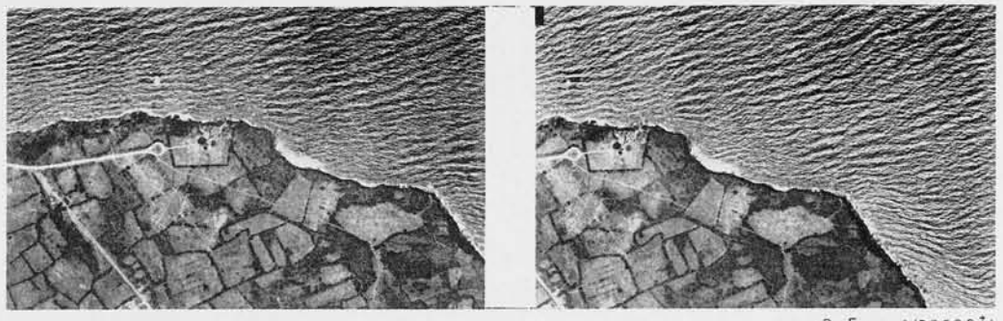
Radio Station at "D" is 700 feet from Radar, and is not related.



(R.F. - 1/13000)

DARIEN, MANCHURIA

Unidentified installation at Darien, Manchuria, which is thought to be a long range Early Warning Coastal Radar similar to the German "Large Hoarding". The screen is 90 feet long by 30-35 feet high, set atop a hill in such a manner as to command the harbor and its approaches.
Signals have been reported from this general area which tend to support this interpretation. Larger scale pictures are necessary for final identification.

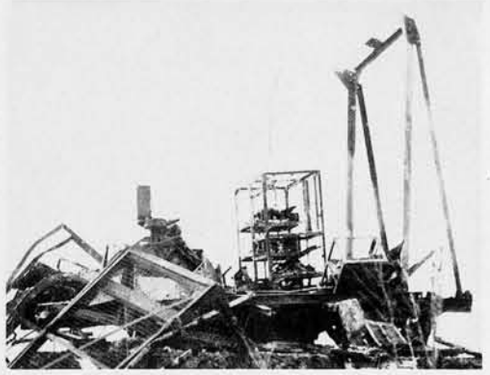


(R.F. - 1/13500±)

EARLY WARNING STATION

A Japanese Coastal Early Warning Station, above, in the Philipines, is sited in a similar manner to many German examples. Station includes, two Radars - an "Attu" type and a "Chi" type.

GUADALCANAL TYPE - SAIPAN



ATTU TYPE - TINIAN

Views of badly damaged Radars captured on Tinian and Saipan illustrate the fact that both the Guadalcanal Type and the Attu Type Radars are still in use in the same general area.
Both of these radars were clearly visible in pre-invasion vertical coverage.

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

RADAR (GERMAN)

SUMMARY

Examples of German Radar are included here to cover the possibility that the Japanese may have access to German equipment and technicians.

The Germans employ several types of land based installations covering the functions of Air Search, Fire Control, and Coast Watching.

These types are quite well standardized and are much more efficient apparatus than those the Japanese are known to have.

There is now some photographic evidence of German Radar equipment in use by the Japanese. Also, it is known that many other types of German electronics equipment are being used.

The following table represents the latest list of German Radar types with salient information concerning each.

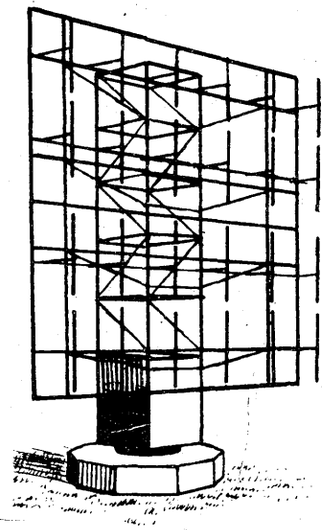
GERMAN LAND BASED RADAR TYPES

NAME	SIZE OF SCREEN*	TOP OF SCREEN ABOVE GROUND	FREQUENCY	RANGE IN NAUTICAL MILES	USE	PAGE NO.
LIMBER FREYA	20'x16' IFF-16¼'x3½'	26 3/4' - 30' WITH IFF	116-146 MCS.	75	A.S.	1.31
POLE FREYA	20'x16' IFF-16¼x3½ OR 20'x8'	32', 35' OR 40' WITH IFF	116-146 MCS.	100	A.S.	1.31
GIRDER CHIMNEY	19½'x97½'	115'	120-130 MCS.	110	A.S.	1.33
CYLINDRICAL CHIMNEY	60'x97½' IFF .22' HIGH	110½'	120-130 MCS.	160	A.S.	1.33
GEMA COASTWATCHER	20'x8'	25'	370-390 MCS.	DEPENDS ON ELEVATION (ASL) OF SITE	C.W.	1.34
LARGE COASTWATCHER	35'x 34'	40'	70-90 MCS.	60-75	C.W.	1.35
SMALL HOARDING	63 3/4 x 44 3/4	50'			C.W.	1.36
LARGE HOARDING	98'x36½'	50'	120-130 MCS.	100-115	C.W.	1.36
SMALL WURZBURG	10' DIAMETER	12½' IN VERTICAL POSITION	550-580 MCS.	25	F.C.	1.37
GIANT WURZBURG	24' DIAMETER	27' IN VERTICAL POSITION	470-580 MCS.	40	G.C.I., A.S. & C.W.	1.38

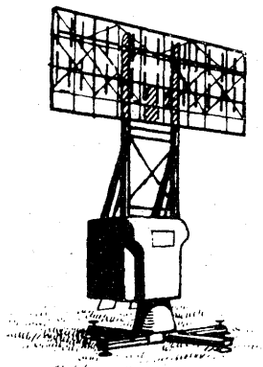
* - WIDTH (HORIZONTAL DIMENSION) GIVEN FIRST
A.S. - AIR SEARCH
F.C. - A/A FIRE CONTROL
C.W. - COAST WATCHING
G.C.I. - GROUND CONTROL INTERCEPT

[redacted]

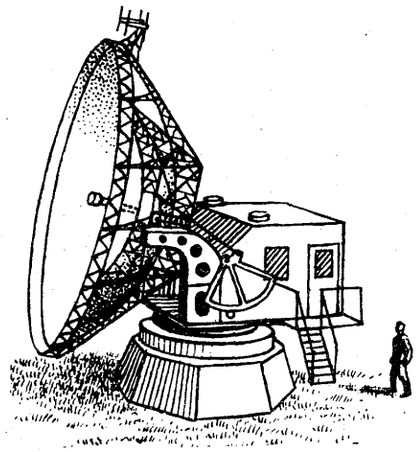
RADAR
SUMMARY (CONT.)



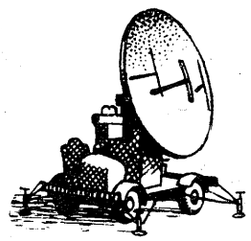
LARGE COASTWATCHER



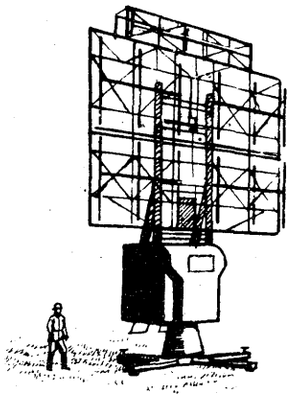
GEMA COASTWATCHER



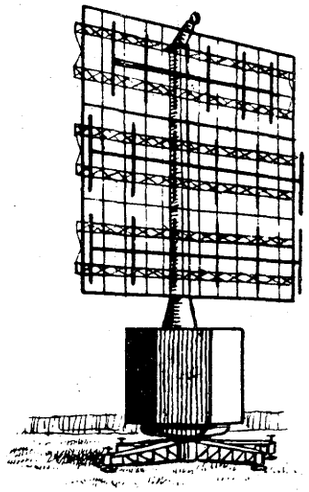
GIANT WURZBURG



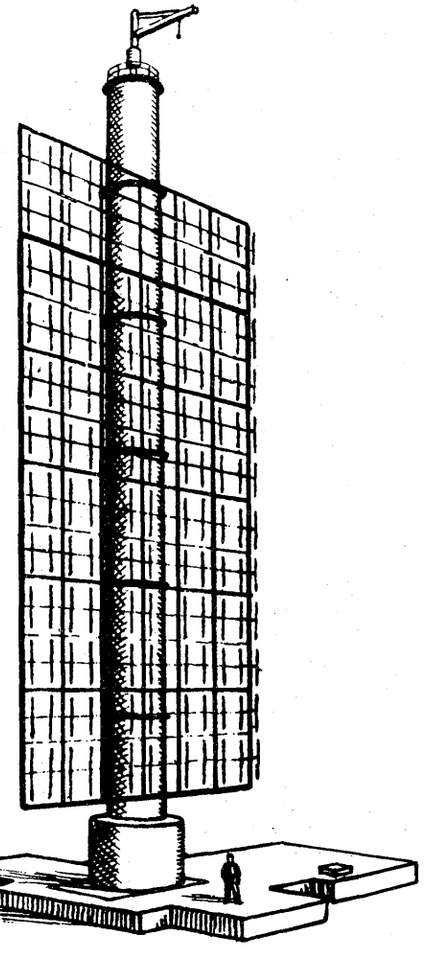
SMALL WURZBURG



LIMBER FREYA



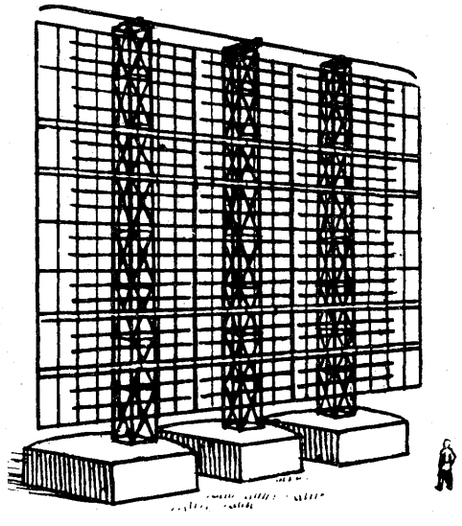
POLE FREYA



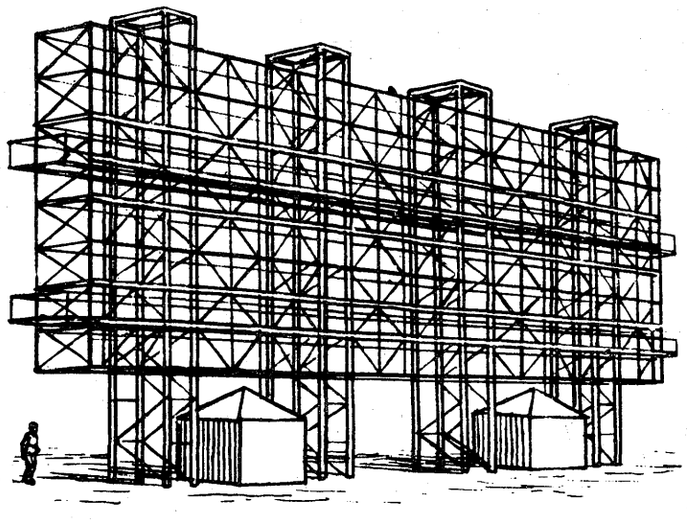
CYLINDRICAL CHIMNEY

Drawings of all of the basic German Radar types are included on this page. Best known popular names are used for the designation of each type. It will be noted that these designs are quite well standardized for each particular use, and identification is easier because of this fact.

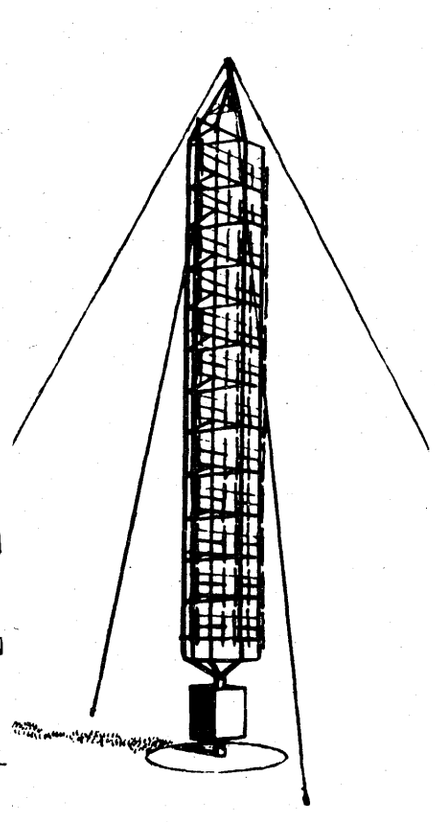
In most cases, this German equipment is superior to that now in use by the Japanese. A constant watch for German type designs of Radar in Japanese held territory is therefore in order.



SMALL HOARDING



LARGE HOARDING

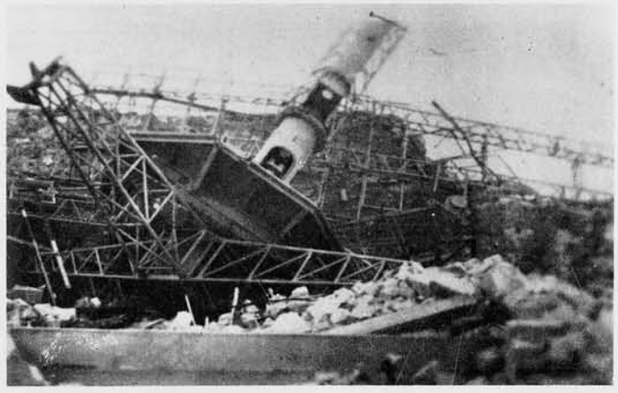


GIRDER CHIMNEY

The Limber Freya is one of the earliest types of German equipment, developed for air search or early warning. The Pole Freya is a later mechanical development, but the electrical performance is much the same. Both types may or may not support the I.F.F. array. The operating cabin is 7' square.

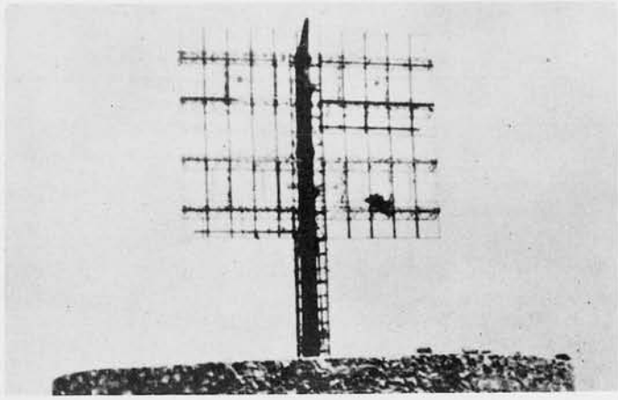
The high blast wall is a characteristic of Freya installations. This Pole Freya is minus the I.F.F. The Pole type is assembled from a number of small parts, thus making it more suitable for air transport.

Practical range of Limber Freya is 75 Naut. miles. Practical range of Pole Freya is 100 Naut. miles. Frequency is 116 - 146 Mcs.

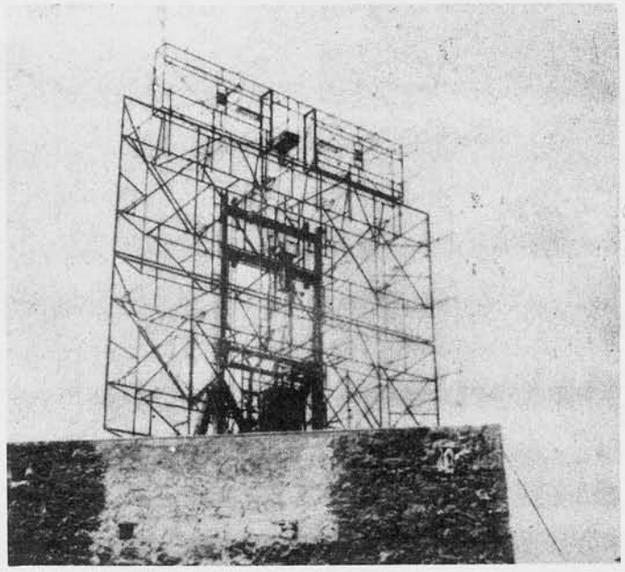


POLE FREYA

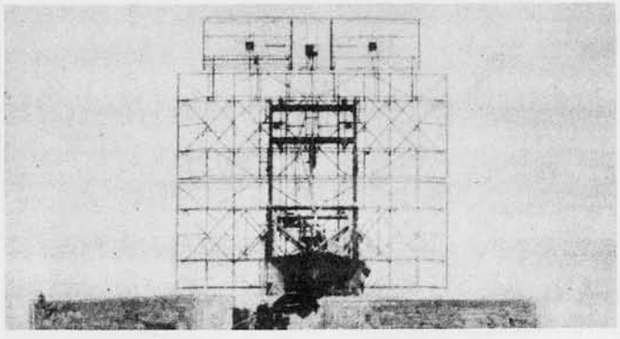
Two views of badly damaged Pole Freya, showing details of the Pole support for aerial and the four arm girder-like base supporting the turn table. The operating cabin is octagonal in plane view (approx. 10' across). Note giant Wurzburg in the background.



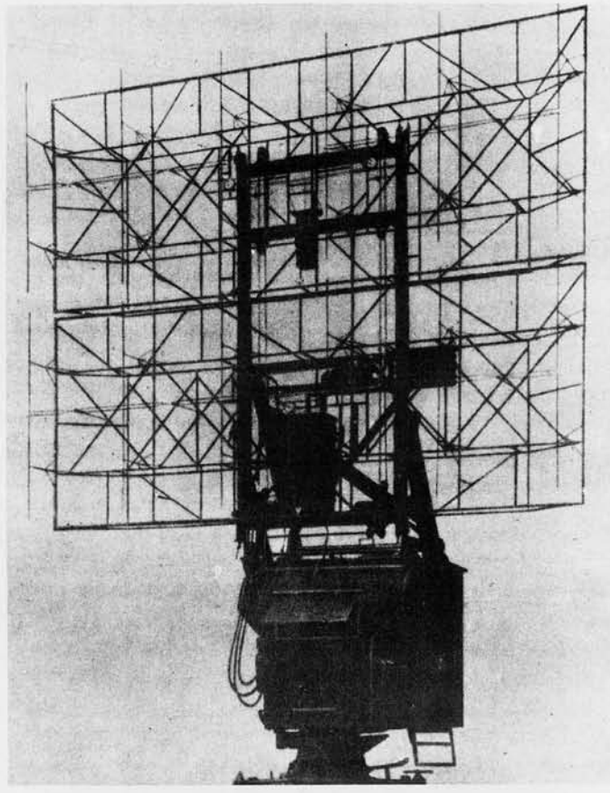
POLE FREYA



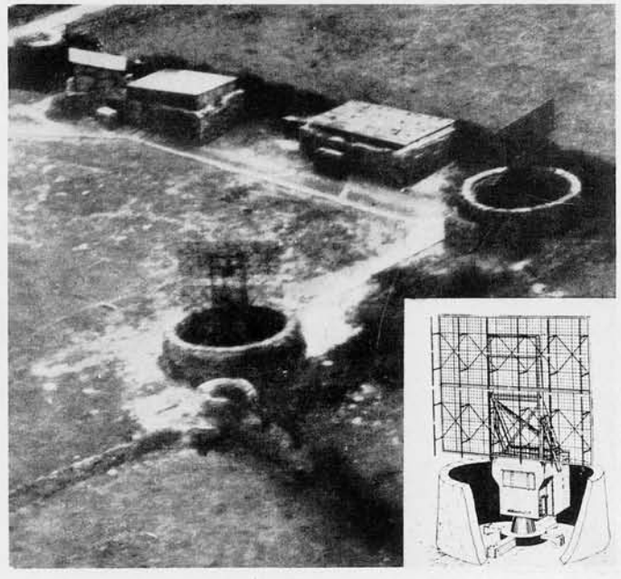
LIMBER FREYA WITH I.F.F.



LIMBER FREYA WITH I.F.F.



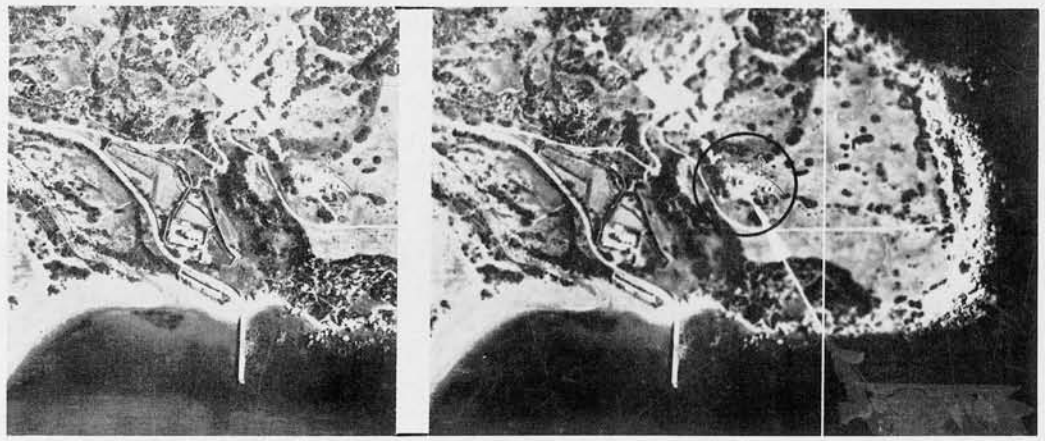
LIMBER FREYA



LIMBER FREYAS

RADAR (GERMAN)

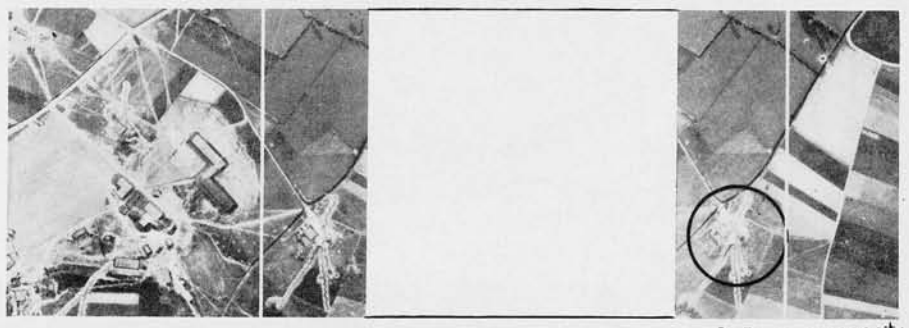
FREYA (CONT.)



(R.F. - 1/8000

FREYA

The Freya is the most used of German Search Radar and is employed in a variety of ways, among which are early warning, ground control of A/C, and coastwatching, etc.

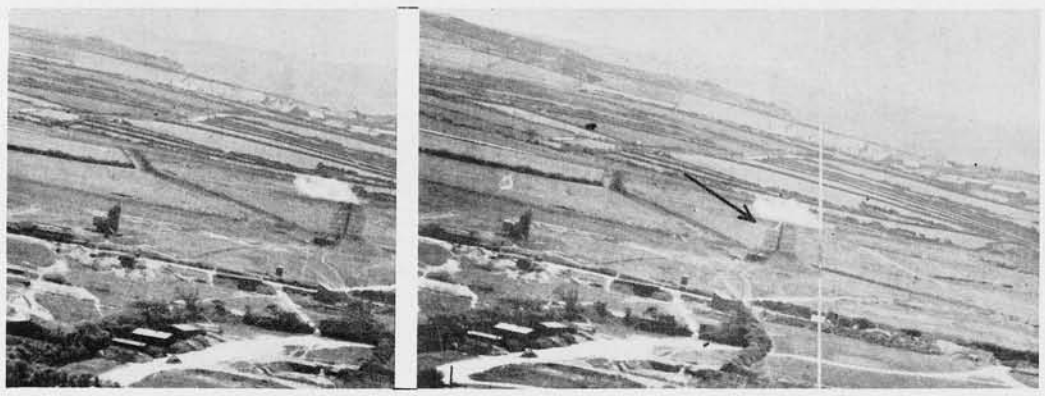


(R.F. - 1/10000±)

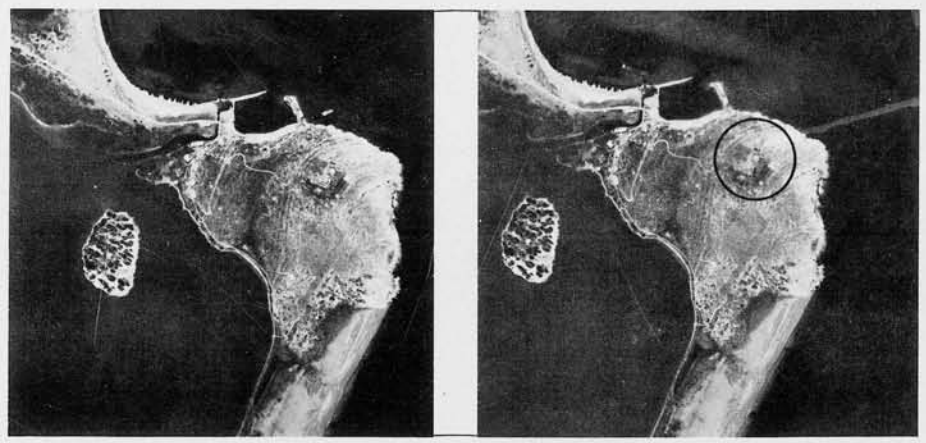
FREYA

Above are seen two Freyas (one in stereo), which appear to be in conjunction with S/L Stations.

The oblique stereogram shown below contains one Pole Freya with 16' wide I.F.F. and one giant Wurzburg.

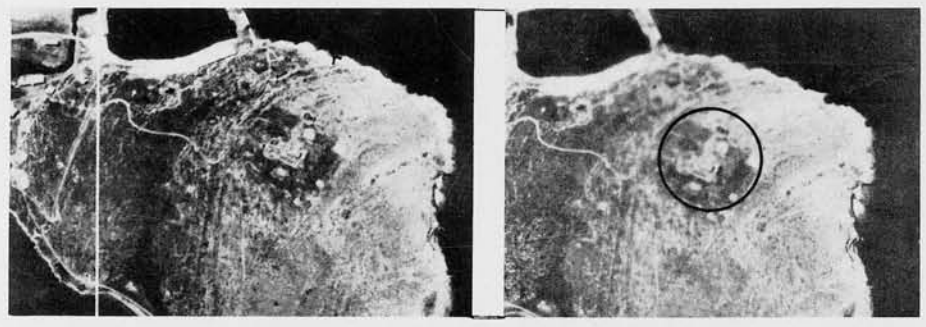


POLE FREYA WITH GIANT WURZBURG



(R.F. - 1/15200)

FREYA



(R.F. - 1/7500)

FREYA

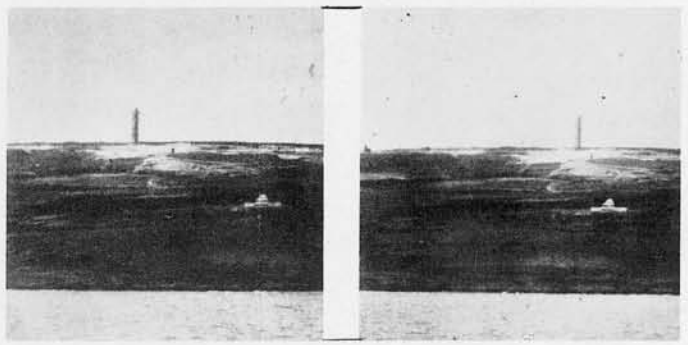
BELOW: This installation in Greece shows a Pole Freya with the 20' wide I.F.F. under attack by a plane. The encircled object appears to be a portable voice carrying light beam signal device which, although of German design, is also in use by Japanese. Its range is approximately 8 miles and it cannot be jammed or intercepted successfully.

POLE FREYA WITH I.F.F.

RADAR (GERMAN)
CHIMNEY

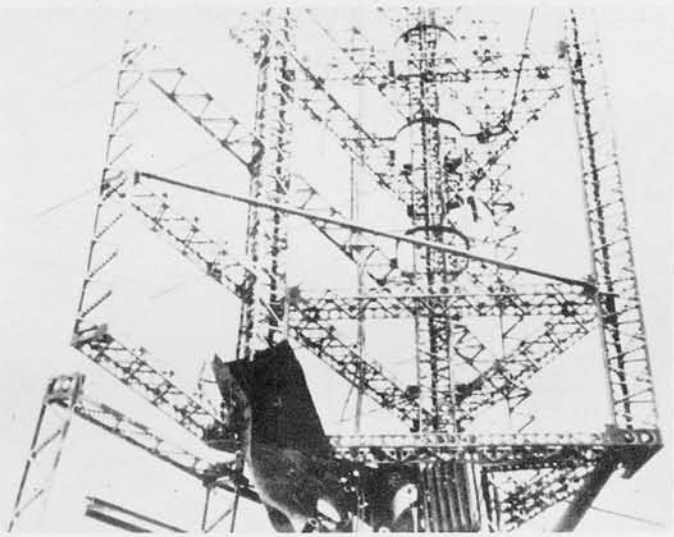
On this page are shown two types of Chimney Radar- the Girder type and the Cylindrical type.
The Girder type consists of a triangular or square (in transverse section) girder mast rising out of a short steel column, which is in turn, fitted to a socket on the ground. The radar equipment is in the cabin at the bottom. Steel guy wires secured at the top, assist in supporting. The screen is 19½' wide by 97½' high.
Practical range is 110 Nautical Miles.
Frequency is 120 - 130 Mcs.
The Cylindrical type has a large partly buried concrete casmate, at one end of which is set up a hollow steel cylinder, 130 feet high and 8 feet in diameter surmounted by a crane arm for hoisting frames into position. The screen varies in width somewhat but is likely to be about 60 feet, usually by 97 1/2 feet high.
Both types rotate, are capable of long range reporting, and operate at the same frequency of 120-130 Mcs.
Practical range is 160 Nautical Miles.
Frequency is 120 - 130 Mcs.

GIRDER CHIMNEY

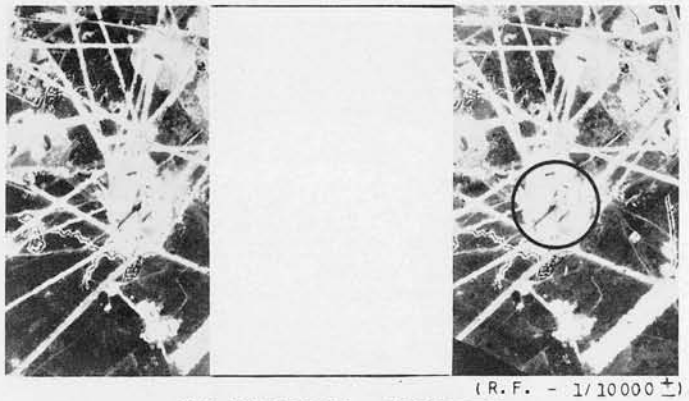


CYLINDRICAL CHIMNEY

The strong vertical form of cylinder is discernable at long distances.



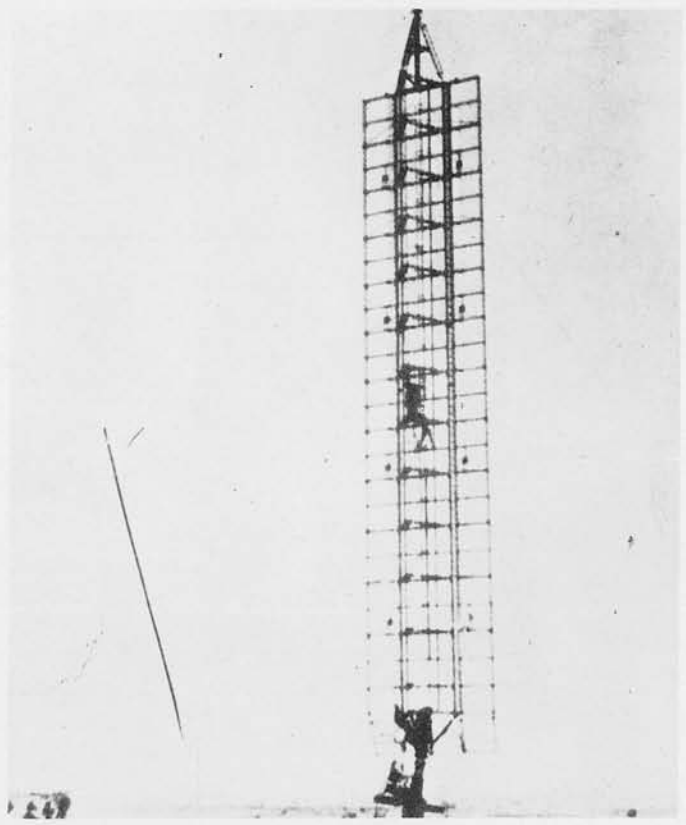
GIRDER CHIMNEY



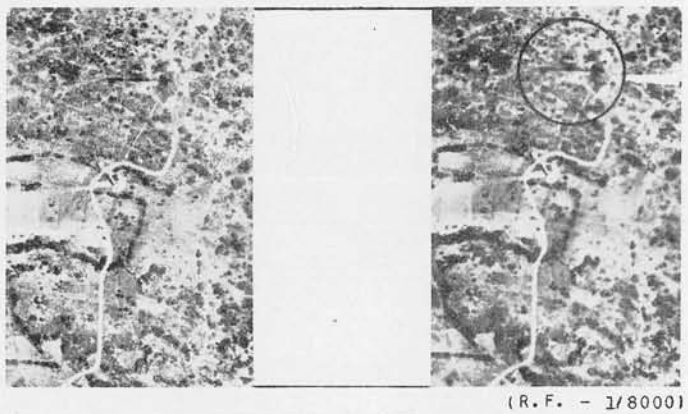
(R.F. - 1/10000 ±)

CYLINDRICAL CHIMNEY

The width of the screen, in vertical view, makes identification comparatively easy.

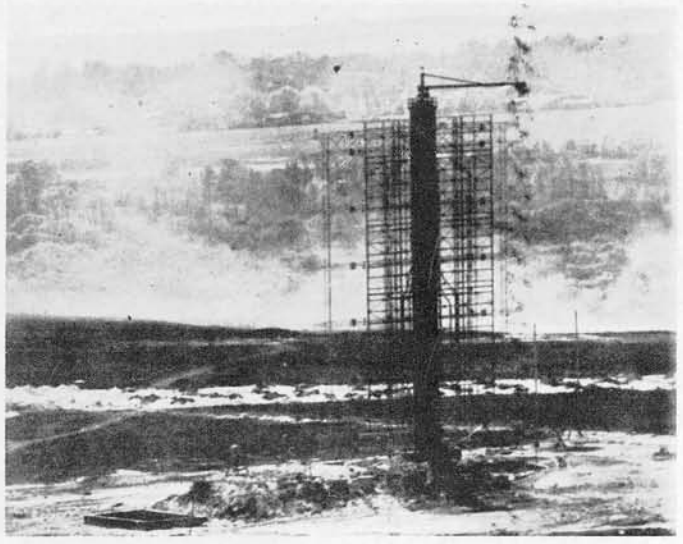


GIRDER CHIMNEY



(R.F. - 1/8000)

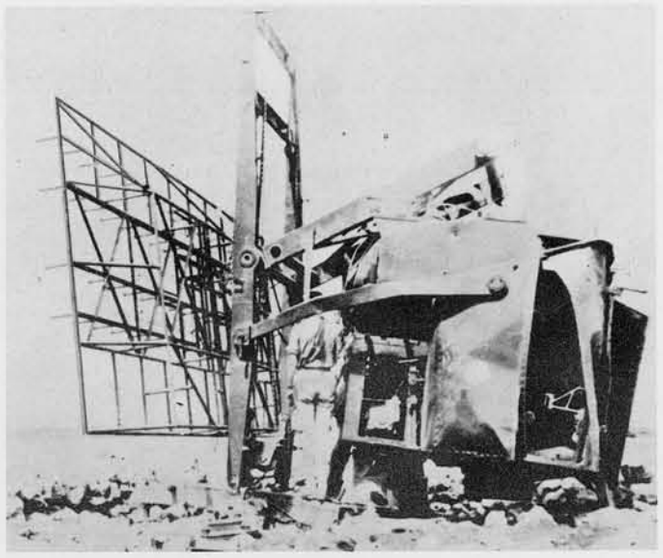
GIRDER CHIMNEY



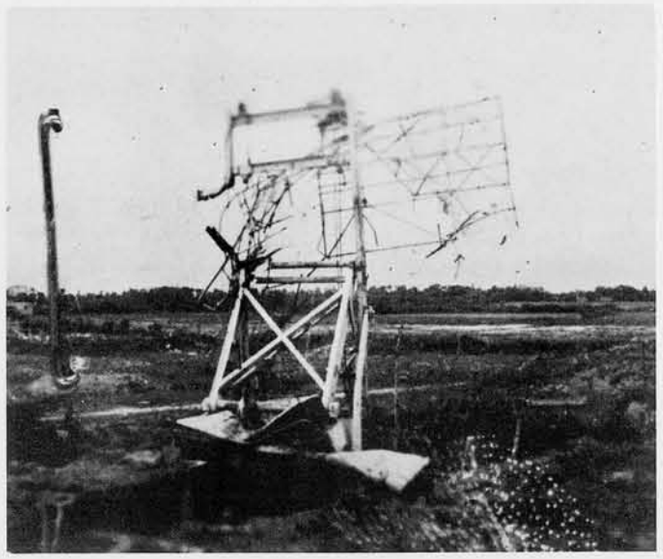
CYLINDRICAL CHIMNEY

RADAR (GERMAN)
COASTWATCHER

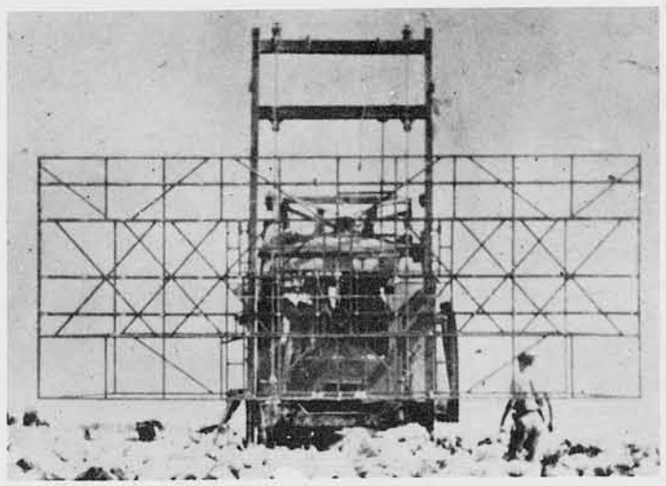
There are two types of German Coastwatcher Radar, the "Gema Coastwatcher" and the "Large Coastwatcher".
The Gema Coastwatcher, shown on this page, is used for detection of ships approaching the coast and for securing range and bearing for fire of coast defense guns.
The aerial is similar to Freya and is 20 feet wide by 8 feet high. The whole apparatus rotates in azinath.
The aerial is always mounted on limbers, but may be sited on the ground or on top of a building such as the octangonal tower shown on this page.
Range varies with the elevation of the set above sea level. It is 20 Naut. Miles at 250 feet A.S.L.
Frequency is 370 - 390 mcs.



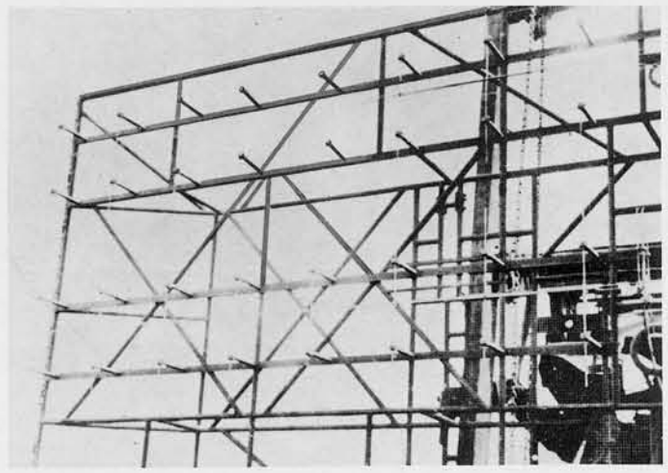
GEMA COASTWATCHER



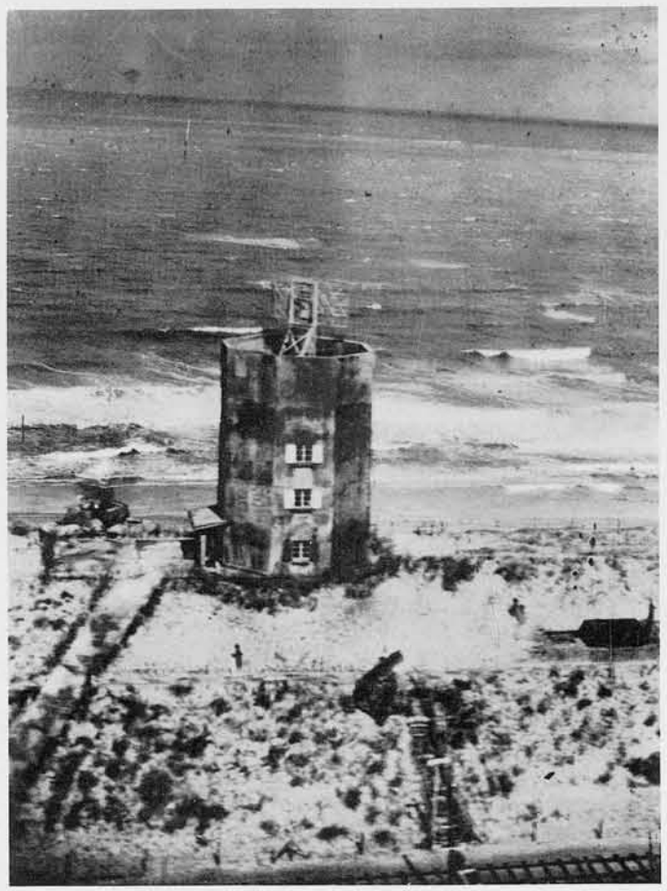
GEMA COASTWATCHER



GEMA COASTWATCHER

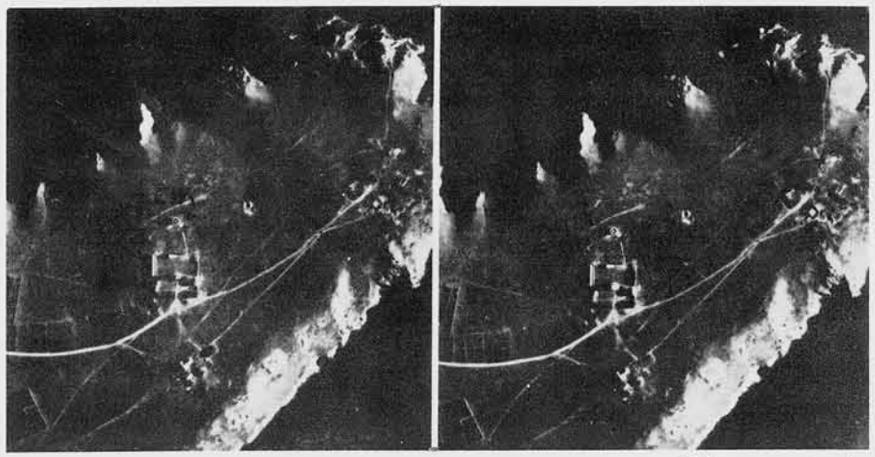


GEMA COASTWATCHER



GEMA COASTWATCHER

GEMA COASTWATCHER



(R.F. - 1/11000±)

GEMA COASTWATCHER

On this page is shown the "Large Coastwatcher" as well as other views of the "Gema Coastwatcher".

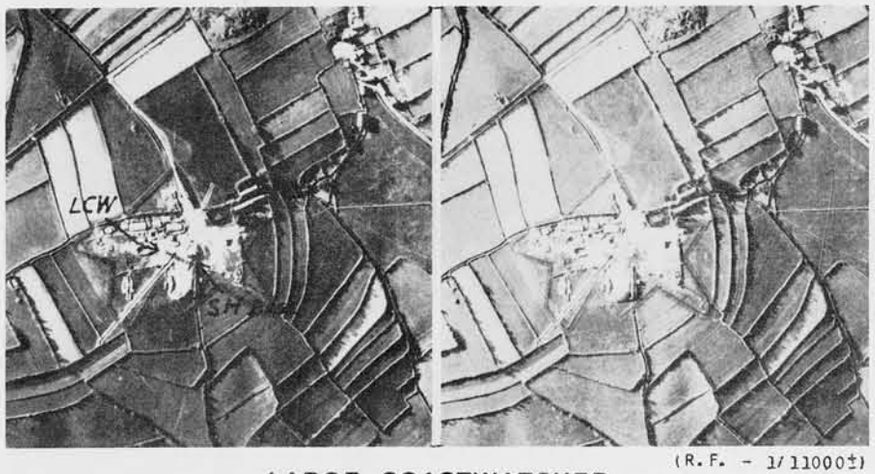
The Large Coastwatcher is a late addition to the list of German Radar, and at the time of the Normandy invasion, little was known in detail concerning its characteristics.

The aerial or screen is nearly square in shape, being 35 feet wide by 34 feet high. The screen and cabin rotate in azimuth.

Its main purpose is the detection of ships.

Practical range of Large Coastwatcher is 60 - 75 nautical miles

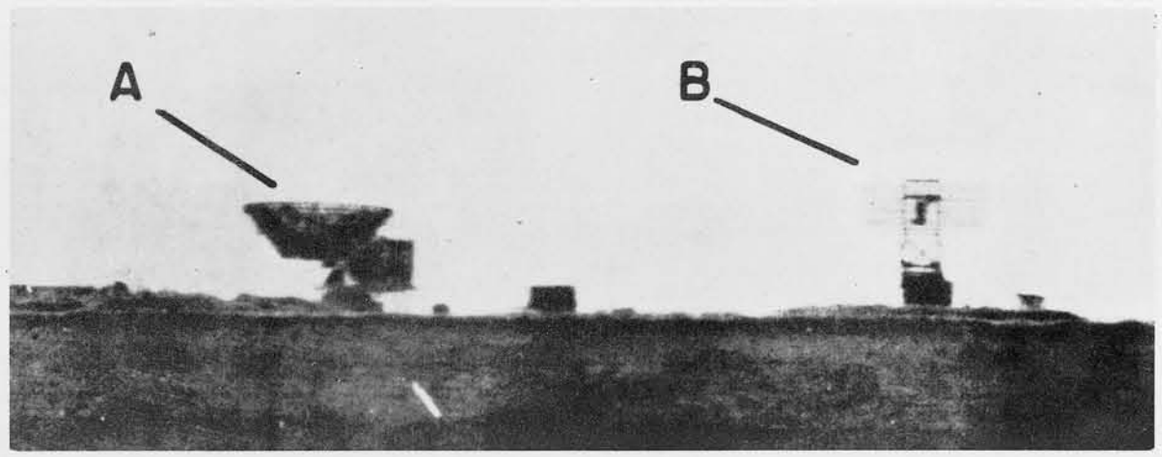
Frequency is 70 - 90 mcs.



(R.F. - 1/11000±)

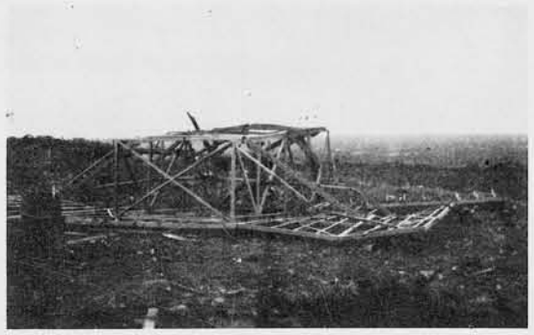
LARGE COASTWATCHER

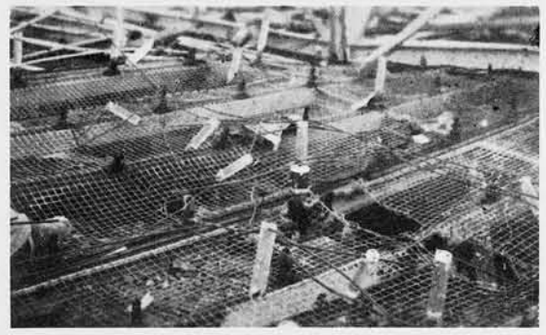
"LCW"- LARGE COASTWATCHER; "SH" - SMALL HOARDING



GEMA COASTWATCHER

"A" - GIANT WURZBURG; "B" - GEMA COASTWATCHER.





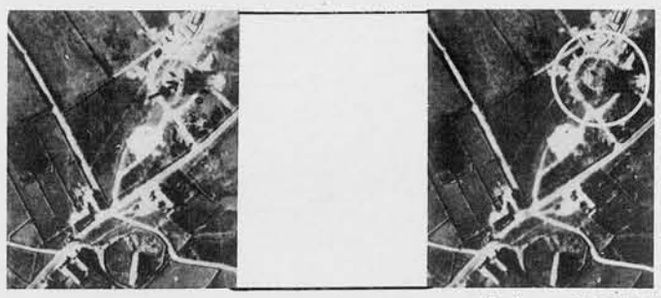
LARGE COASTWATCHER

LARGE COASTWATCHER

RADAR (GERMAN)

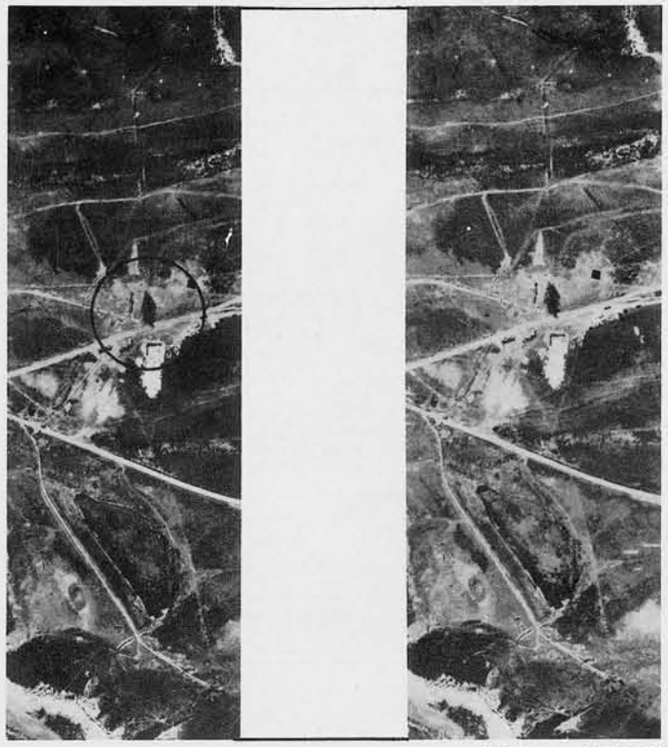
HOARDING

The "Hoarding" apparatus (sometimes called "Mammut") is for long range aircraft reporting, measuring range and bearing. The screen is fixed and is not capable of rotation. Searching is achieved by electrical swinging of the beam. The Large Hoarding consists of a screen 98 feet long by 36½ feet high, looking very much like a billboard. Four heavy vertical girders set in concrete bases give support to the screen. The screen usually consists of two fixed broadside arrays, one attached to each side of the vertical girders.
Practical range of Large Hoarding is 100 - 115 Nautical Miles. Frequency is 120 - 130 Mcs.



(R.F. - 1/11000)

LARGE HOARDING



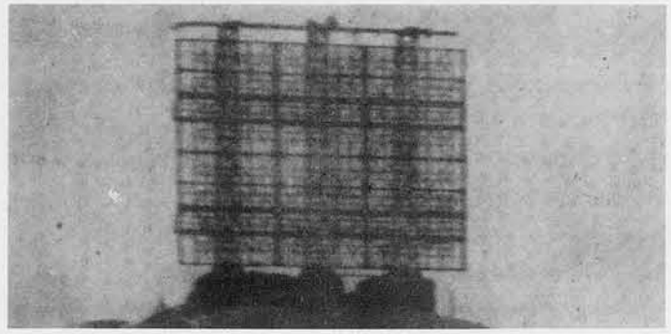
(R.F. - 1/10000)

LARGE HOARDING

A very recent type of German Radar is the Small Hoarding. This apparatus is probably also for coastwatching, and bears a strong similarity to the Large Hoarding, although smaller.

The screen is 63 3/4 feet long by 44 3/4 feet high and is supported by three vertical girders set in concrete bases. The two outside bases are larger than the middle one.

At the top of the vertical girders runs a horizontal rail or bar, which is probably used for hoisting screen into place.

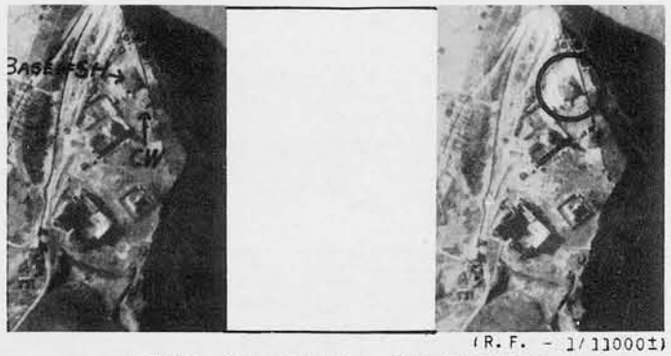


SMALL HOARDING

LARGE HOARDING

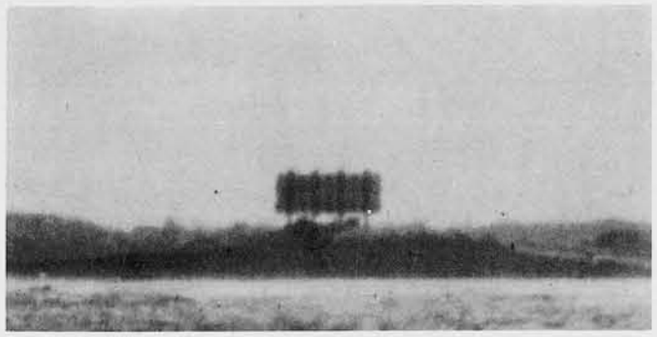
(R.F. - 1/5700)

LARGE HOARDING

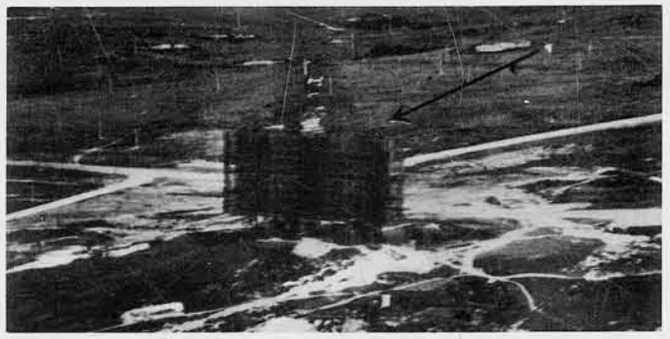


(R.F. - 1/11000±)

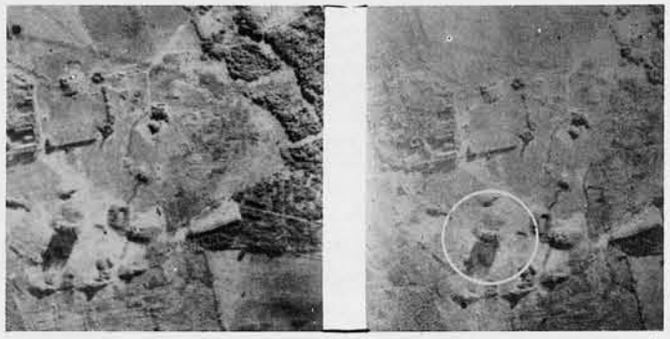
BASE OF SMALL HOARDING



LARGE HOARDING



LARGE HOARDING



SMALL HOARDING (R.F. - 1/9000±)

CONFIDENTIAL

RADAR (GERMAN)
SMALL WURZBURG

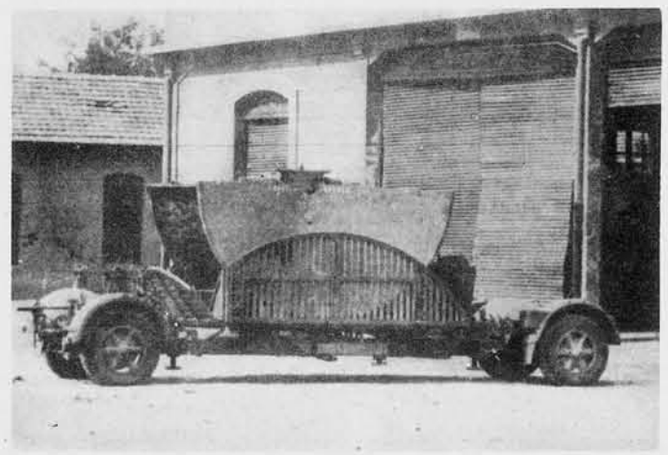
The "Small Wurzburg" or "Bowlfire" was first designed in 1936, and is one of the most efficient Radars. It is primarily for A.A. fire control but has been used for A/C reporting, searchlight control, and as a standby for Ground Control of A/C. In general, it is a mobile Radar, mounted on a four-wheeled trailer with outriggers for levelling. Some sets are emplaced, however, and the wheels removed.

Search is by mechanical rotation of the apparatus for bearing and by elevation of the reflector bowl for height measurement.

The diameter of the paraboloid reflector is 10 feet, the top of which is but 12½ feet above the ground. A cupboard, housing the radar equipment, and an operators seat are attached to the rear and side of the reflector.

There are several types of Small Wurzburgs; among them Types "A", "C", and "D" are most used and are quite similar. Type "D" is found with limber mounting and may be without wheels or even set in concrete.

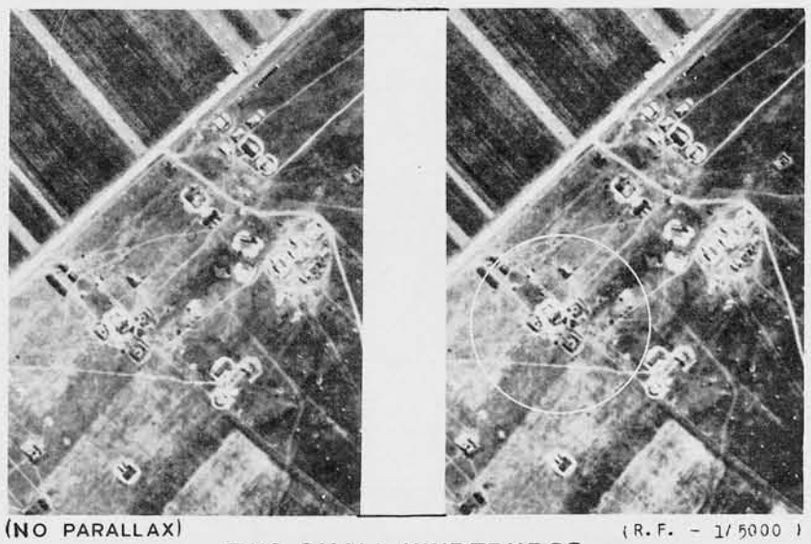
For transport, the paraboloid can be split, by hinges, and turned down in two halves. (See below)



WITH BOWL TURNED DOWN

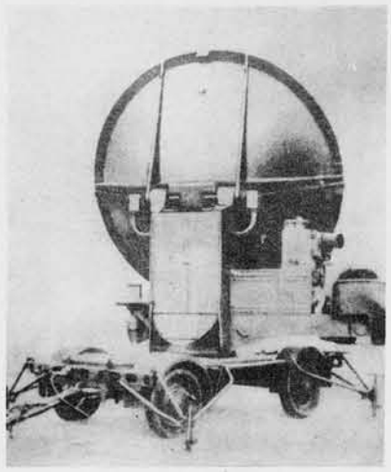
RIGHT: Type F.M.G. 41-T is a modification of the Small Wurzburg which incorporates a scoop-like form for cutting out ground echoes.

The practical range of the Small Wurzburg is not more than 25 nautical miles but it has a high degree of accuracy for Fire Control purposes.

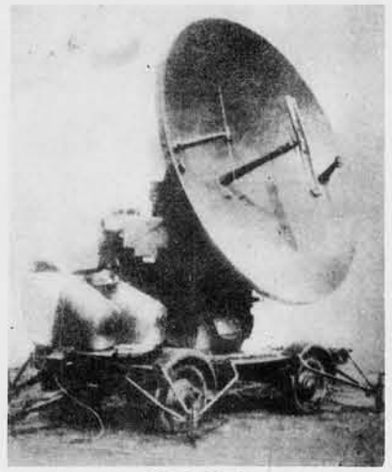


(NO PARALLAX) (R.F. - 1/5000)

TWO SMALL WURZBURGS

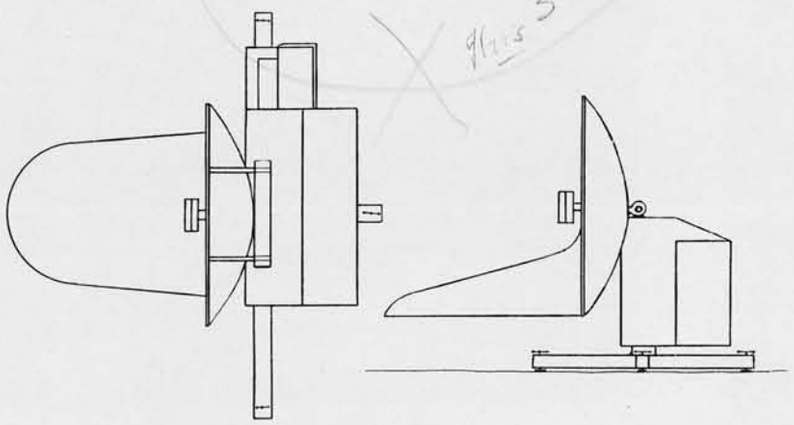


REAR

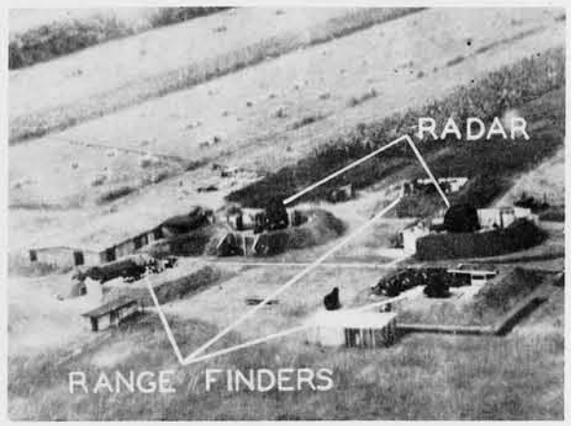


FRONT

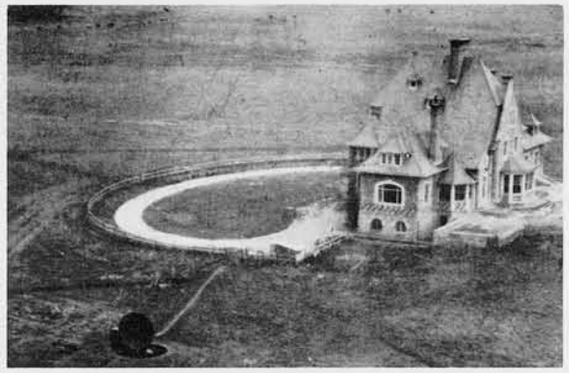
SMALL WURZBURG



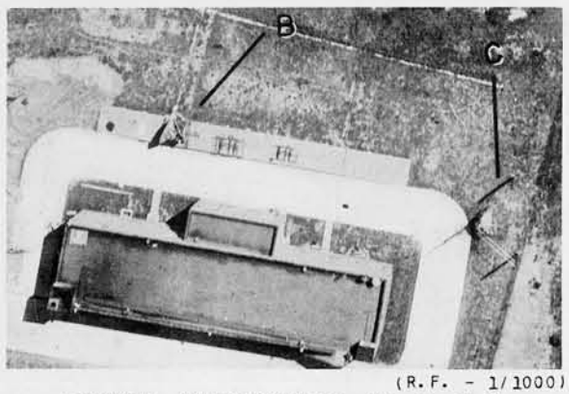
MODIFICATION OF SMALL WURZBURG



TWO SMALL WURZBURGS

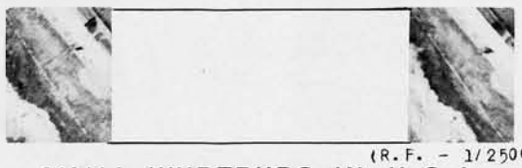


SMALL WURZBURG AT BRUNEVAL



(R.F. - 1/1000)

SMALL WURZBURG IN U.S.A.



(R.F. - 1/2500)

SMALL WURZBURG IN U.S.A.

CONFIDENTIAL

RADAR (GERMAN)

GIANT WURZBURG

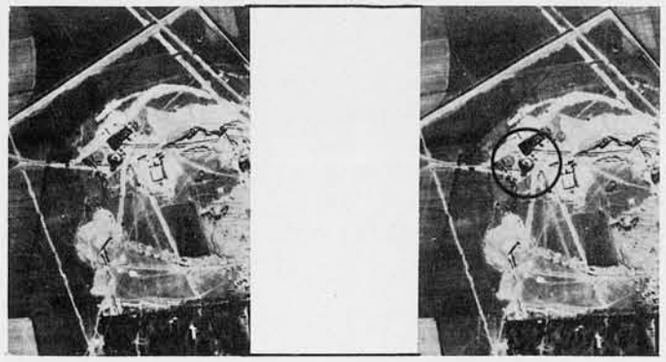
The Giant Wurzburg is a fixed (non-mobile) Radar for measuring range, bearing and height of target aircraft. The whole equipment rotates in azimuth, and the paraboloid tips upward for height finding. Its principal use is for Ground Control Intercept, but some are used for ship-watching.

The basket type metal paraboloid has a diameter of 24 feet.

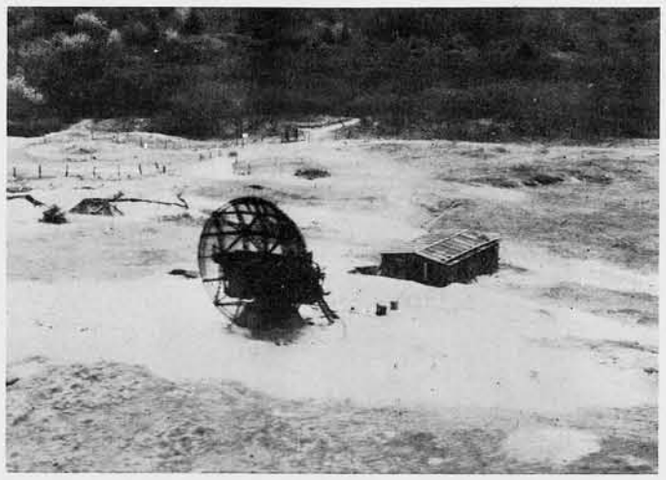
The large cabin (16' x 10' x 8½' high) rotates with the screen on a turntable which is, in turn, set on a concrete base. In upright position, the top rim of the paraboloid is 27 feet above the ground. An I.F.F. array, consisting of two pairs of dipoles, is located at the top of the paraboloid rim.

The Giant Wurzburg has been used in great numbers throughout German occupied Europe as a multi-purpose Radar. Practical range of the Giant Wurzburg is 40 N. Mi. Frequency is 470-580 Mcs.

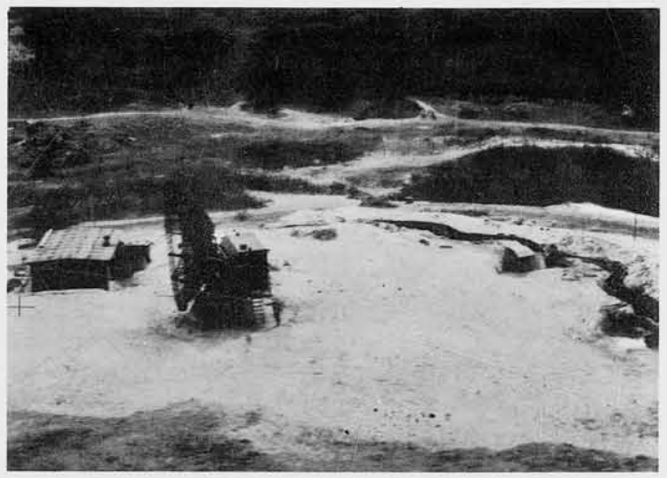
GIANT WURZBURG



GIANT WURZBURG (R.F. - 1/8500)

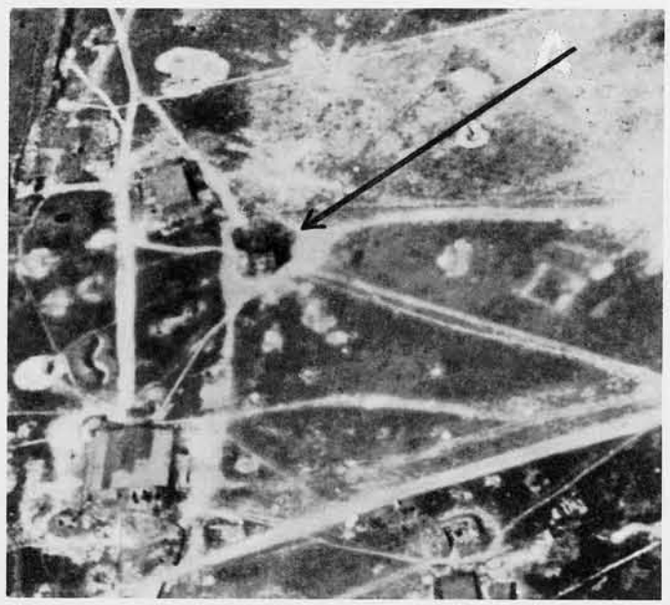


GIANT WURZBURG

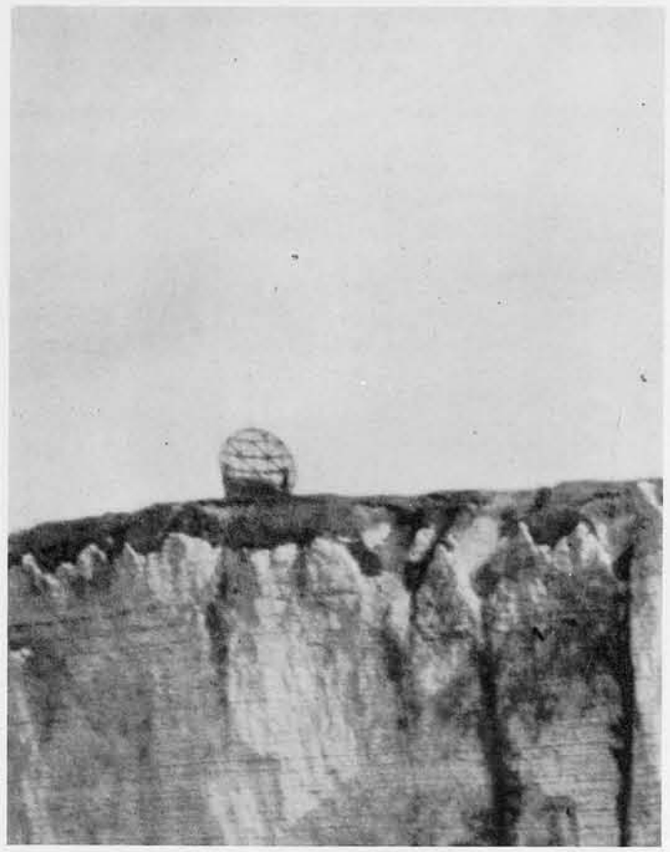


GIANT WURZBURG

GIANT WURZBURG NEAR COAST



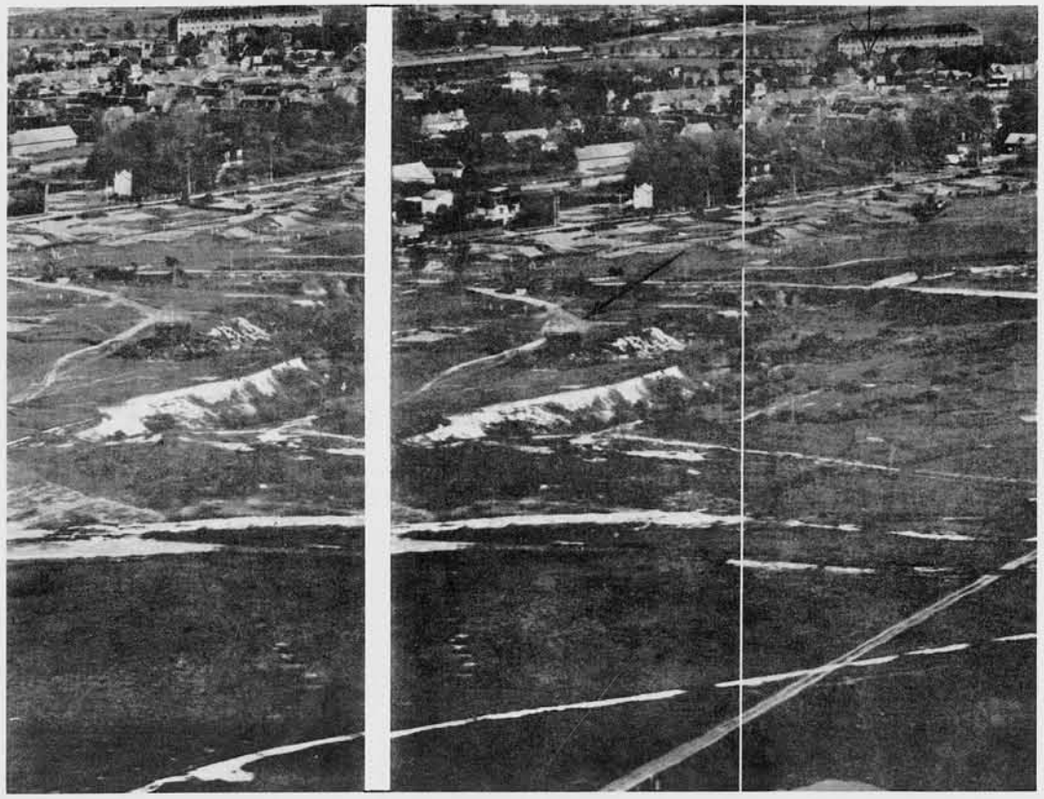
GIANT WURZBURG



GIANT WURZBURG AS COASTWATCHER

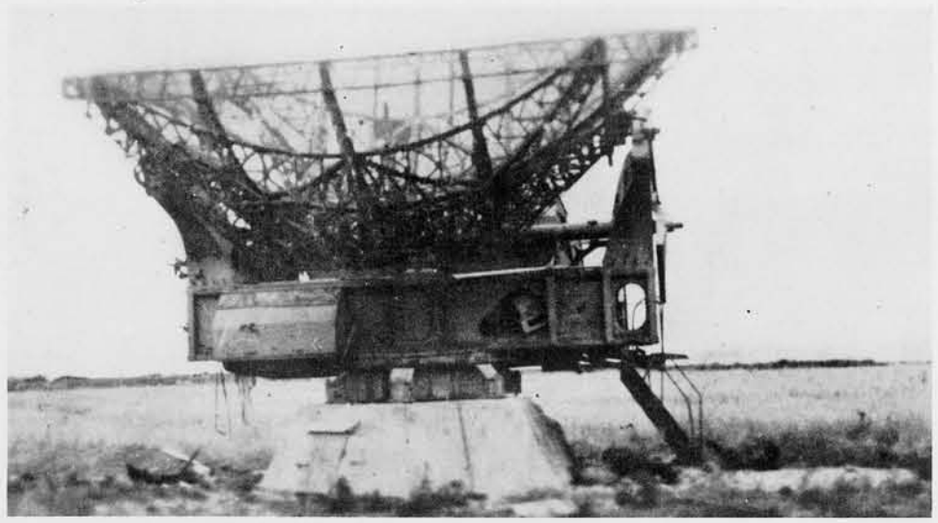
RADAR (GERMAN)

GIANT WURZBURG (CONT.)

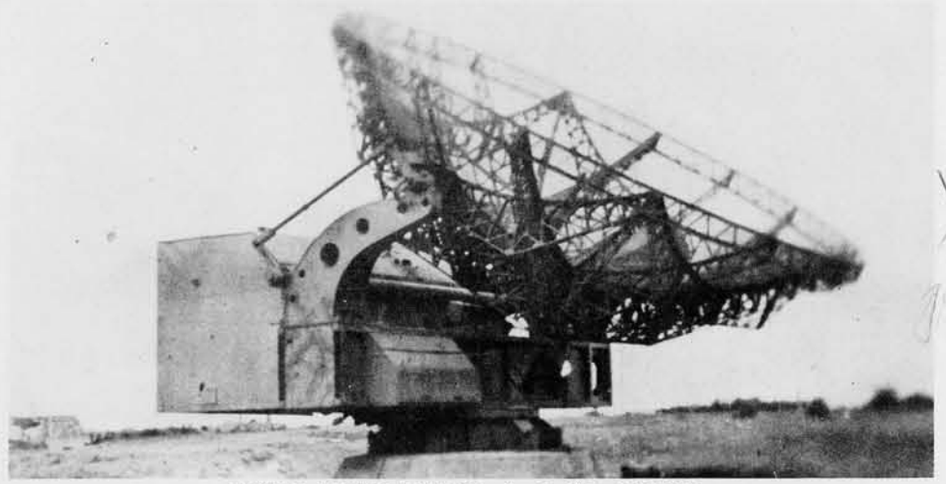


GIANT WURZBURG

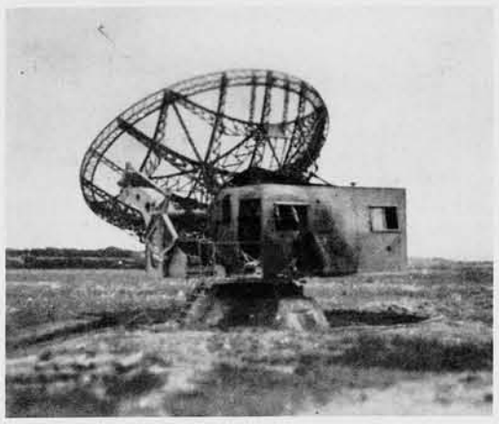
Most of these views show the paraboloid of the Giant Wurzburg in uplifted position. The girders are of a light metal alloy. The "Basket" form is used instead of a "Bowl", because of wind resistance offered by such a large surface area.



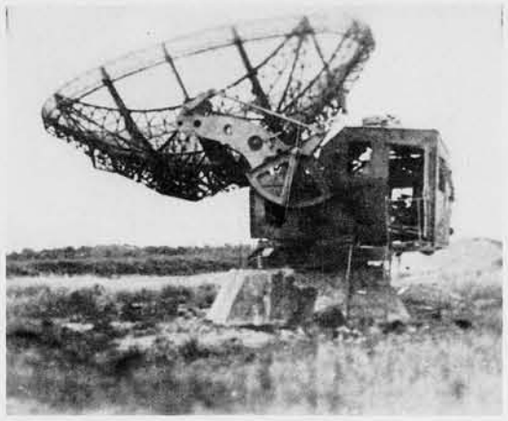
GIANT WURZBURG – FRONT VIEW



GIANT WURZBURG – 3/4 VIEW



GIANT WURZBURG – REAR VIEW



GIANT WURZBURG – SIDE VIEW

G.W. SUPPORTING TRUNNIONS

G.W. I. F. F. ARRAY

CONFIDENTIAL

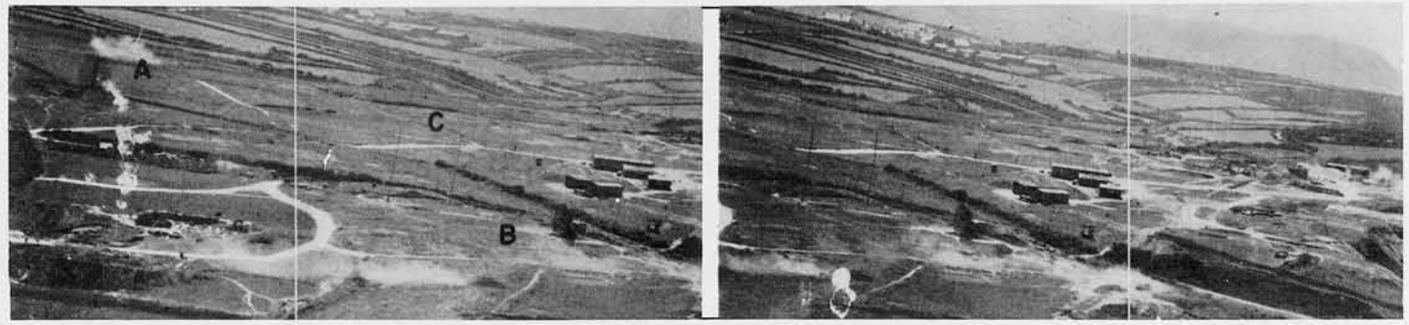
RADAR (GERMAN)
COMBINATIONS

Most German Radar stations, excepting some Hoarding and Chimney sites and a few Ship Watching sites, are provided with several pieces of equipment.

The most common station, the Coastal Early Warning Station, usually has two Freyas and one or two Wurzburgs. The Freyas are in circular emplacements.

The typical G.C.I. station has two Giant Wurzburgs, one Freya, and occasionally a Small Wurzburg.

Ship watching stations have one Coastwatcher and a Small or Giant Wurzburg.



RADAR STATION - FRANCE

"A" - POLE FREYA; "B" - GIANT WURZBURG; "C" - RADIO COMMUNICATIONS

Large Radar Stations such as these have not yet been seen in the Japanese war. However, these examples indicate how well-organized Early Warning and Ground Control Intercept stations may appear.

RADAR STATION - FRANCE

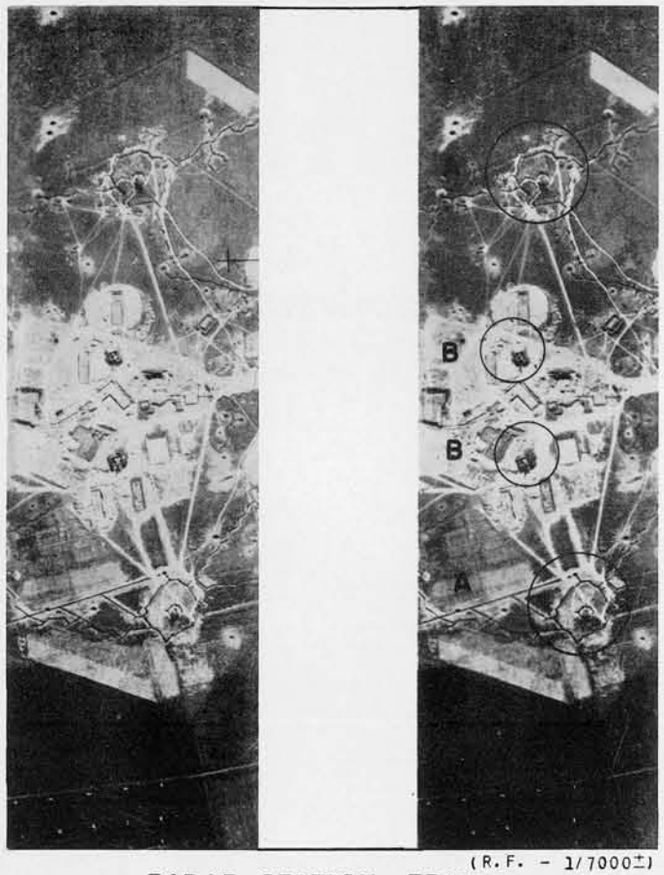
"A" - LARGE COASTWATCHER

"B" - GIANT WURZBURG

RADAR STATION - FRANCE

"A" - RADIO COMMUNICATIONS "C" - POLE FREYA

"B" - 2 GIANT WURZBURGS



(R.F. - 1/7000±)

RADAR STATION - FRANCE

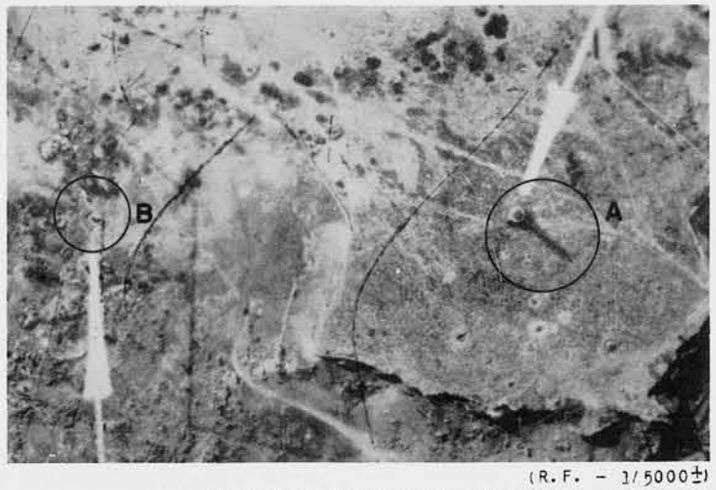
"A" - 2 GIANT WURZBURGS

"B" - 2 LIMBER FREYAS

RADAR STATION - FRANCE

"A" - 2 LIMBER FREYAS

"B" - 1 GIANT WURZBURG



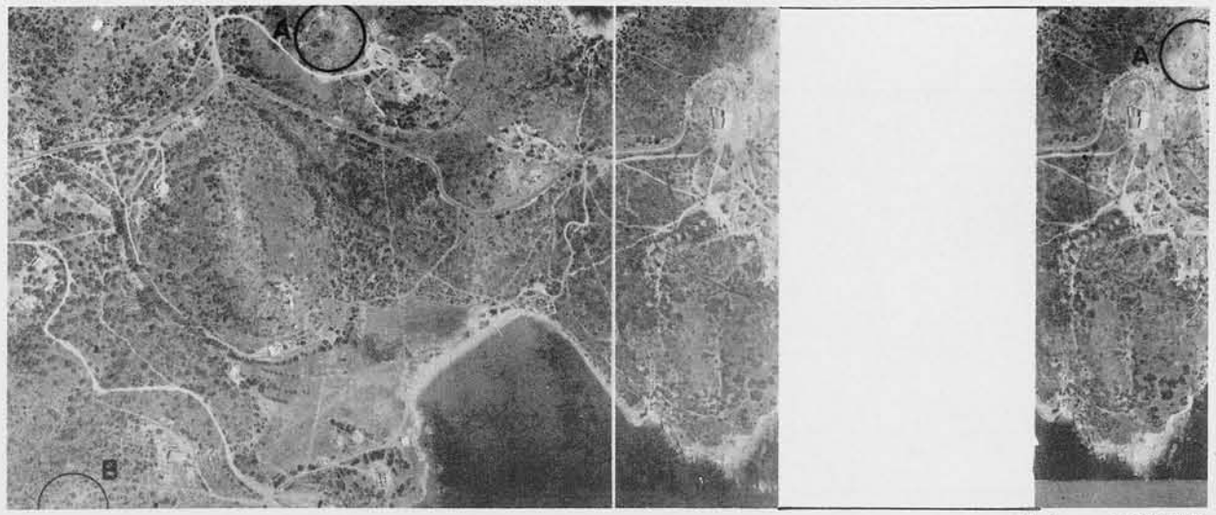
(R.F. - 1/5000±)

RADAR STATION - CRETE

"A" - GIRDER CHIMNEY

"B" - SMALL WURZBURG

RADAR (GERMAN)
COMBINATIONS (CONT)



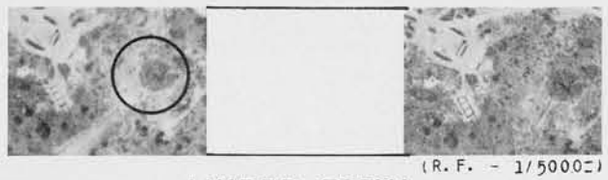
(R.F. - 1/10000±)

RADAR STATION - GREECE

"A" - 2 LIMBER FREYAS; "B" - GIANT WURZBURG

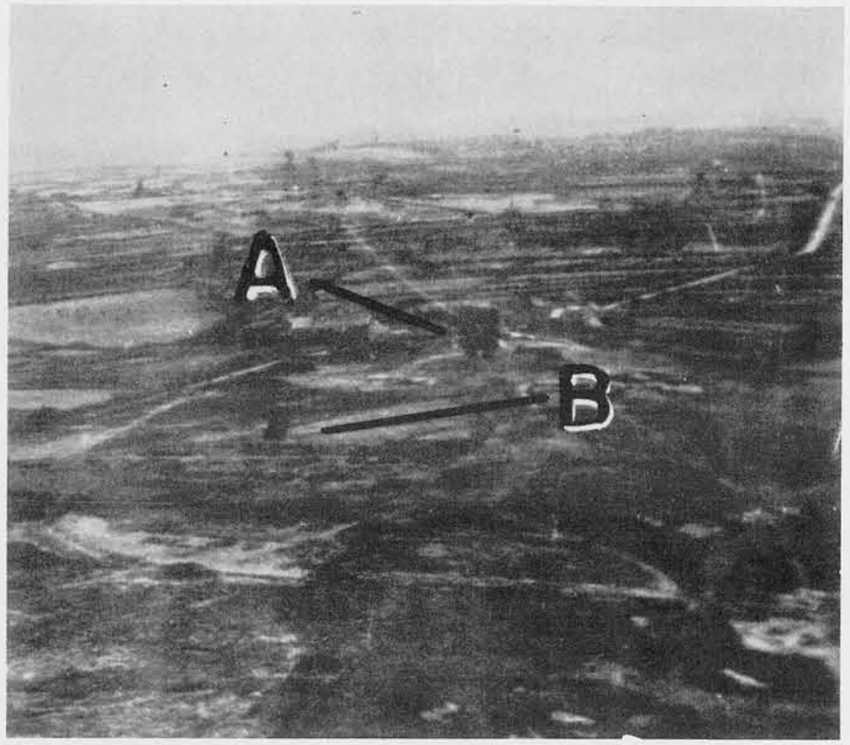
(R.F. - 1/5000±)

GIANT WURZBURG



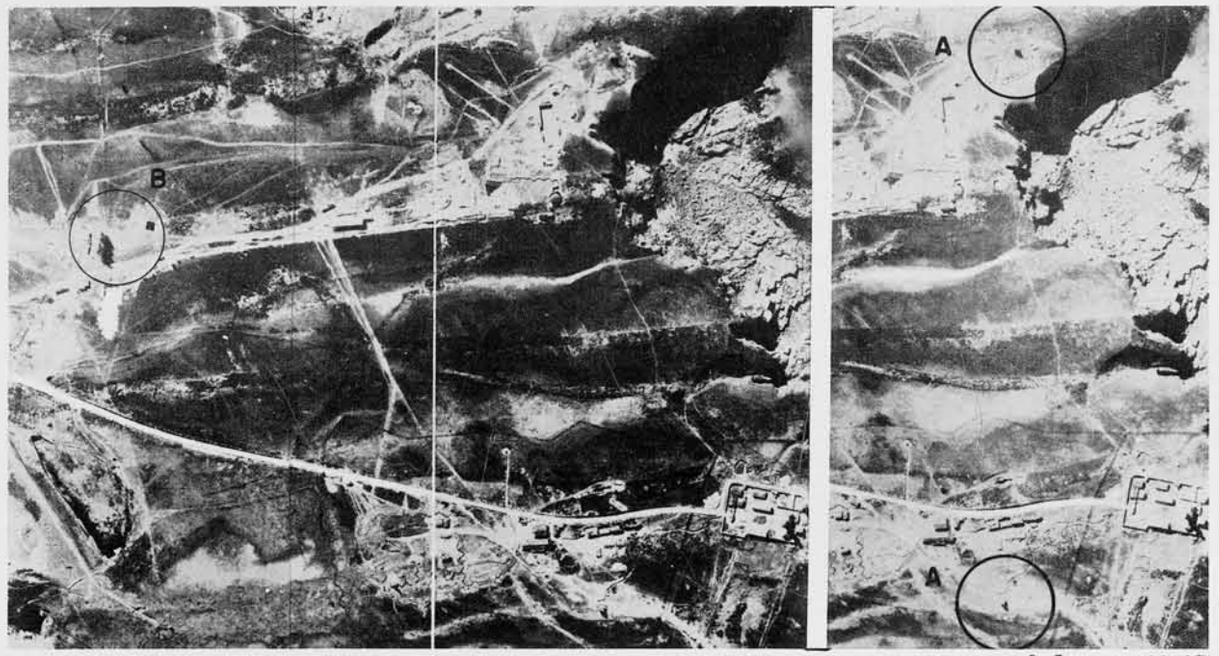
(R.F. - 1/5000±)

LIMBER FREYA



RADAR STATION - FRANCE

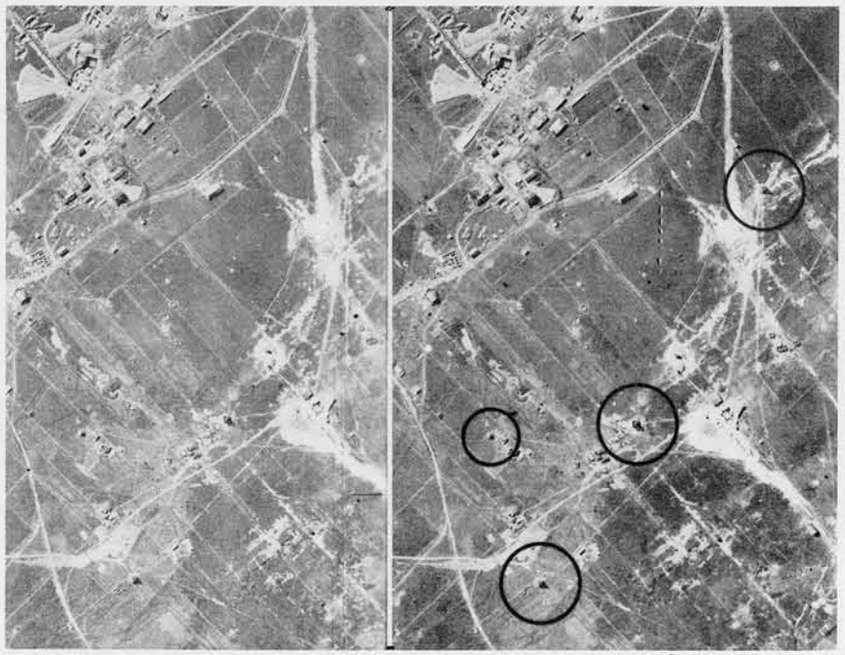
"A" - LARGE HOARDING; "B" - GIANT WURZBURG



(R.F. - 1/10000±)

RADAR STATION - FRANCE

"A" - 2 GIANT WURZBURGS; "B" - LARGE HOARDING



(R.F. - 1/8000±)

RADAR STATION - FRANCE

"A" - 2 GIANT WURZBURGS; "B" - FREYA; "C" - SMALL WURZBURG

CONFIDENTIAL

SECTION-2

2.01 — 2.99

COMMUNICATIONS

ALLIED STANDARD FREQUENCY TABLE

SUPER HIGH FREQUENCY (MICRO-WAVE)	3000 - 30,000 Mcs.
ULTRA HIGH FREQUENCY	300 - 3,000 Mcs.
VERY HIGH FREQUENCY	30 - 300 Mcs.
HIGH FREQUENCY	3 -30 Mcs.
MEDIUM FREQUENCY	0.3 - 3 Mcs. (300-3000 Kcs.)
LOW FREQUENCY	0.03 - 0.3 Mcs. (30-300 Kcs.)
VERY LOW FREQUENCY	0.01 - 0.03 Mcs. (10-30 Kcs.)

Frequency bands of Radio Communications Stations do not fall exactly into the breakdown listed above. Also, it is impossible to determine exact frequencies by means of photographic interpretation alone.

To prevent confusion, the following system is used in this report:

If it is thought that the frequency band of a station overlaps the divisions listed in the standard breakdown, the dominant frequency will dictate the frequency band as called for in the above table.

For example, if a transmitter will operate from 300 to 600 Kcs., it will be called "Medium Frequency" for purposes of classification because 3/4 of this frequency band of 400 Kcs. (or 300 Kcs.) falls into the standard "Medium Frequency" division.

Many standardized Japanese Communication Centers, utilizing three 75 foot high steel lattice masts, are believed to fall in this catagory. They may be more exactly referred to as being fairly powerful Low-Medium Frequency stations with reliable ranges of greater than 500 miles.

When a station is catalogued as being of a certain frequency, the classification also presumes the possibility of another transmitter being present, operating at higher frequencies. However, the general classification of the station is still derived by an estimate of its dominant lowest frequency.

[redacted]

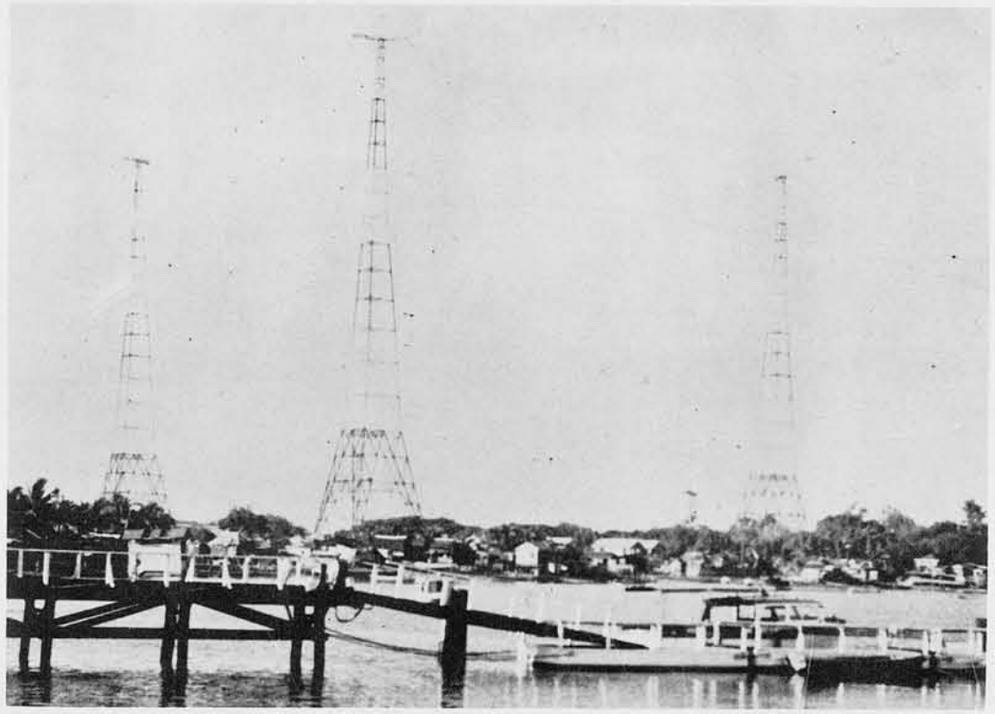
COMMUNICATIONS
SUMMARY

Radio communication plays a very important part in the Japanese military system and has been developed to a great extent, both in quality and quantity. German technical skills are known to have contributed to the former, and for years the Japanese themselves have been building an elaborate communications network throughout their widely dispersed empire.

The problem of interpreting radio communications installations correctly and precisely is more complex than with other electronics equipment, even though the installation may often be catalogued as "radio" at a glance.

Apparently conscious of their "Achilles heel" of communication, the Japanese have followed a policy of duplication of installations, multi-frequency set-ups, camouflage, well protected power plants etc. A typical coral atoll, for example, will contain three or four large stations operating over hundreds of miles, and countless small stations, difficult to spot on aerial photographs.

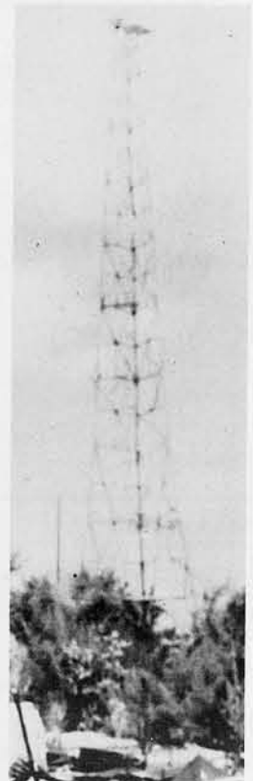
In addition to these are well made semi-portable and portable transmitters and receivers,& hand-held walky-talkies. Also, weather stations, communications auxiliary to D. F. installations, and Radio ships.



PHILIPPINES

This U.S. station in the Philippines is more powerful than is likely to be found in most Japanese controlled areas. At the present time the mast at the far left is missing. However, the enemy is thought to be using the two remaining masts in connection with a station now operated by them. These are called "lattice masts" and are 600' high, with a spread at the base of 125' or more. Masts of Japanese design, found to date, are usually not over 350' in height.

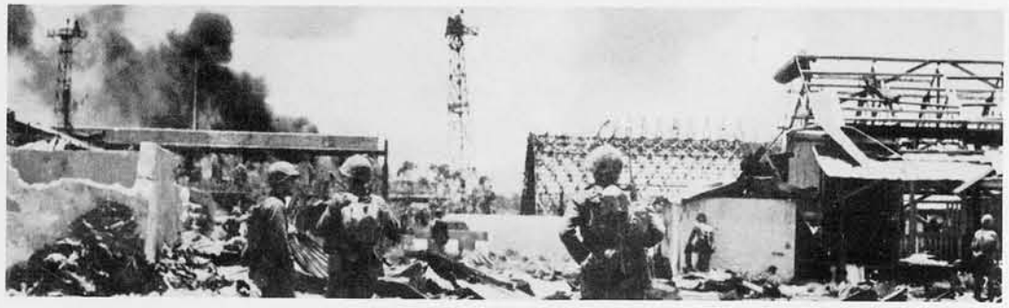
SAIPAN, MARIANAS



SAIPAN

TINIAN, MARIANAS

(R.F. - 1/5000)



TINIAN, MARIANAS

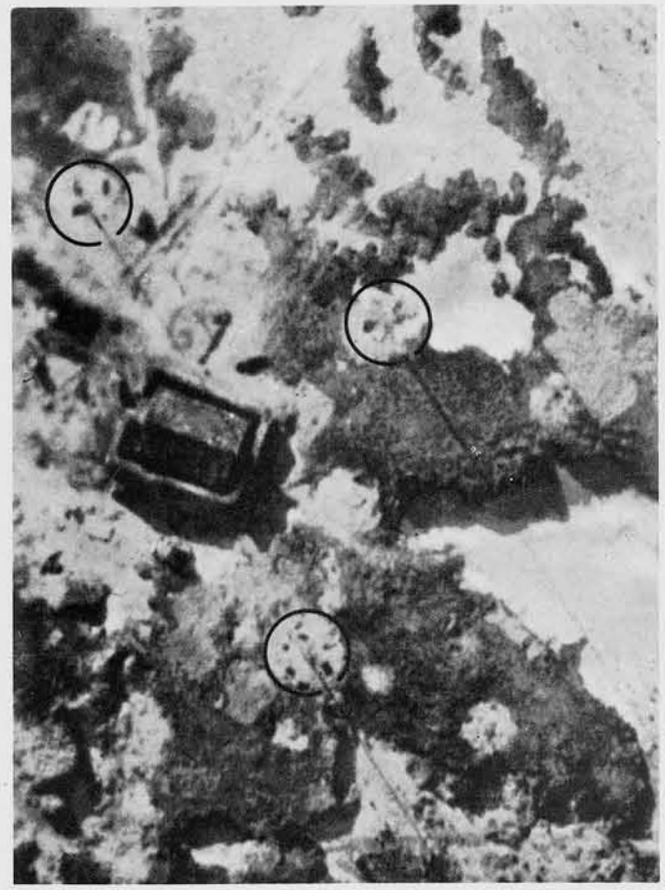
CONFIDENTIAL

COMMUNICATIONS

SUMMARY (CONT.)

In this section an attempt has been made to treat more exactly than heretofore, the interpretation of fixed radio installations, based solely on features that can be seen by the Photographic Interpreter.

In that antennae can seldom be seen on aerial photos, masts are of primary importance in interpreting radio communications. In vertical photos mast location, type and height can often be determined by the shadows they cast on the ground.



(R.F. - 1/2000)

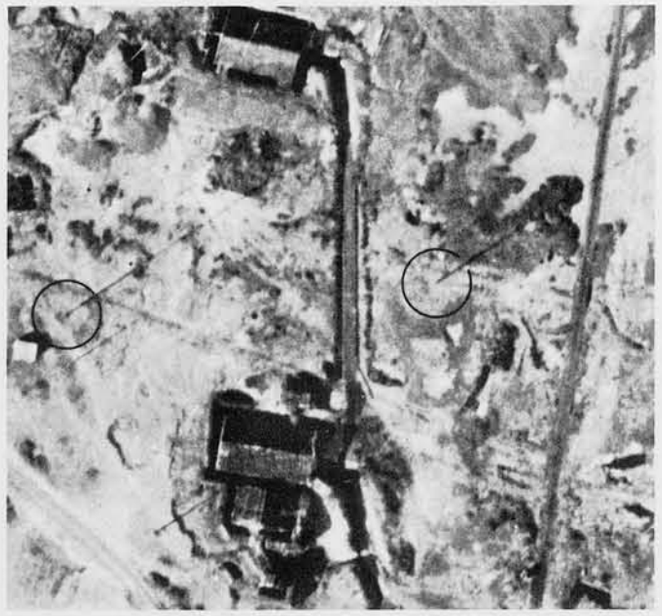
KISKA

ABOVE: In this view of a 3 mast Kiska station, the masts would not be visible were it not for the shadows cast by them.

The masts usually surround, or are close to the transmitting building.

RIGHT: Antennae and lines supporting masts are barely visible here at an elevation of 100 feet. Few pictures afford this amount of detail, however.

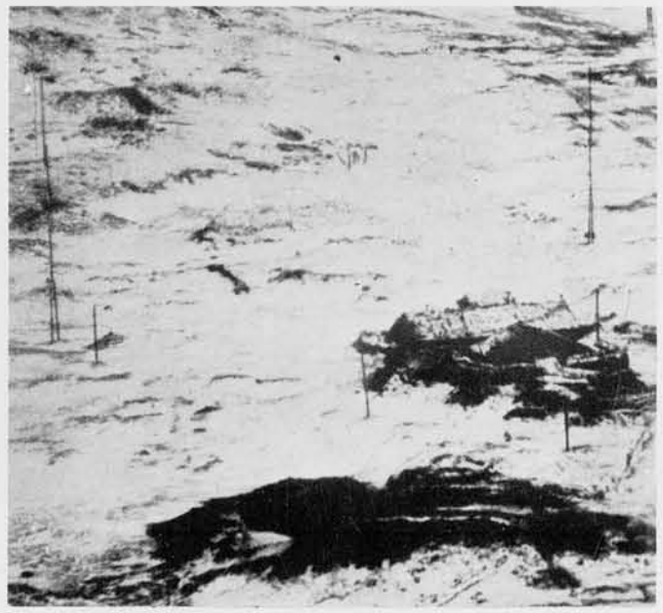
BORAM, NEW GUINEA



(R.F. - 1/2000)

KISKA

ABOVE: This 2 mast Kiska station contains 75' spliced wooden masts and smaller power line poles crossing diagonally at lower left of picture.



KISKA

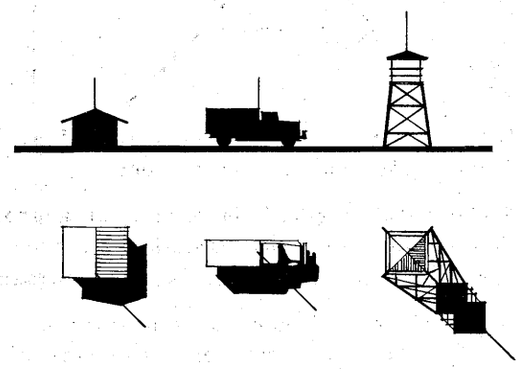
ABOVE: Low oblique of masts and poles. This spliced mast design is usually 75' high and is a favorite of the Japanese.

COMMUNICATIONS
SUMMARY (CONT.)

On this page are shown examples of the various mast designs in use by the Japanese. Shadow patterns are indicated to stress the importance of this method of interpretation.

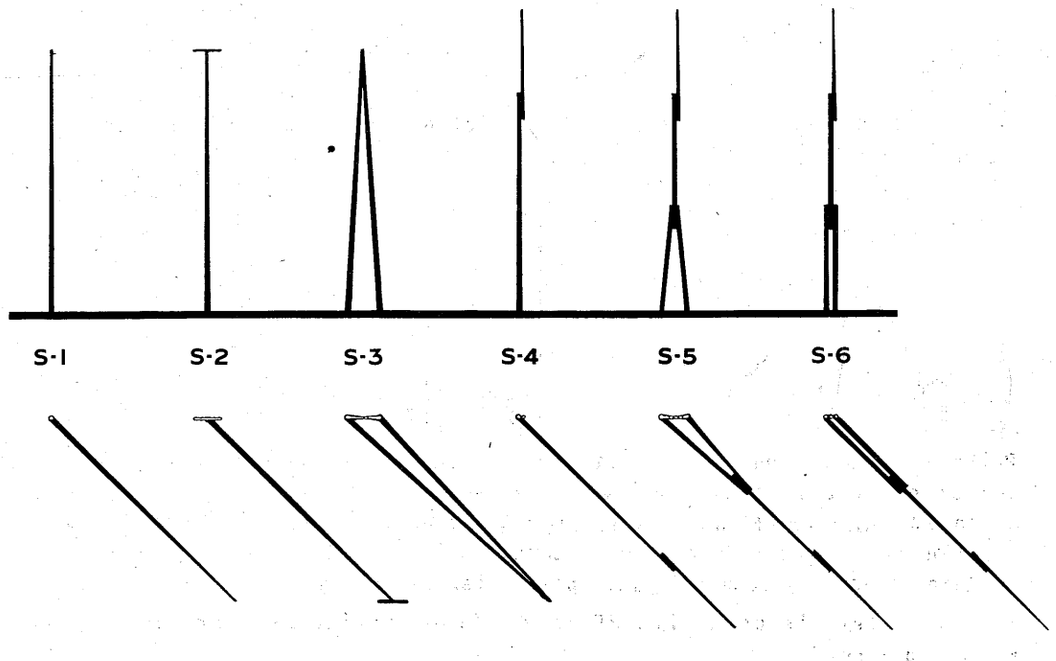
WHIP MASTS

There are many other types and locations in connection with portable, mobile, ship and aircraft equipment, which are usually impossible to interpret adequately in small scale vertical photography.



STICK MASTS

Below are shown six designs of stick masts found in Japanese areas. With the exception of S-1 and S-2 these are generally between 50 feet and 75 feet in height. S-5 and S-6 are usually 75' high. With good photography it is often possible to determine exact design, even at fairly small scale.

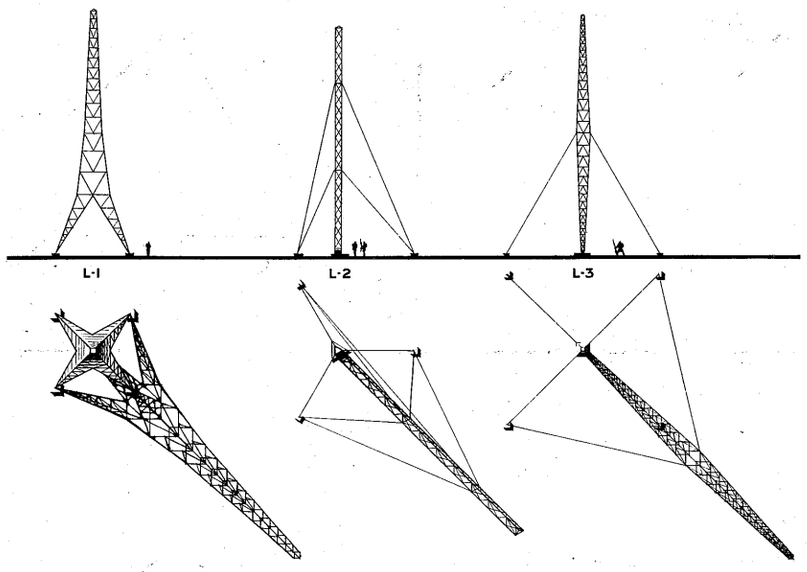


LATTICE MASTS

A great variety of designs occursin lattice type masts. They are usually of steel construction with prefabricated members. The following diagrams show certain basic types which are frequently found with enemy installations.

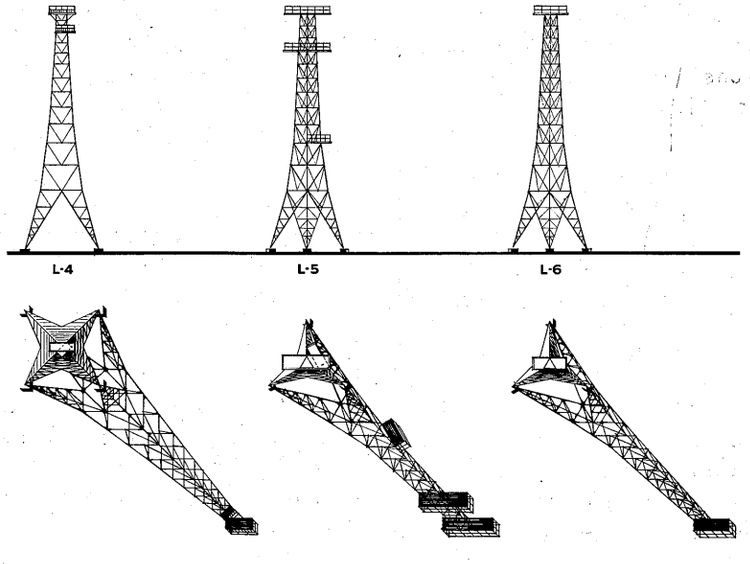
L-1, L-2, and L-3 are more typical of occidental design, and often indicate pre-war broadcast stations.

Lattice masts may range in height from 60 feet to 600 feet with the majority falling between 75 feet and 300 feet.



PLATFORMS

Lattice masts with Japanese military radio stations usually have platforms as indicated below. L-5 is likely to be found in threes and is normally 75 feet high.



COMMUNICATIONS

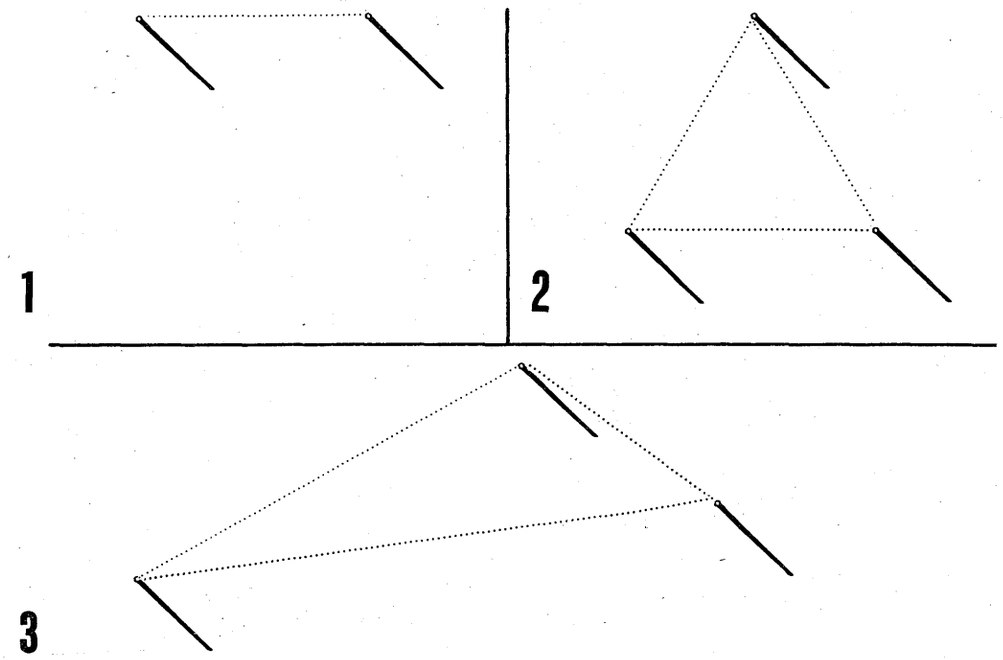
SUMMARY (CONT.)

MAST PATTERNS

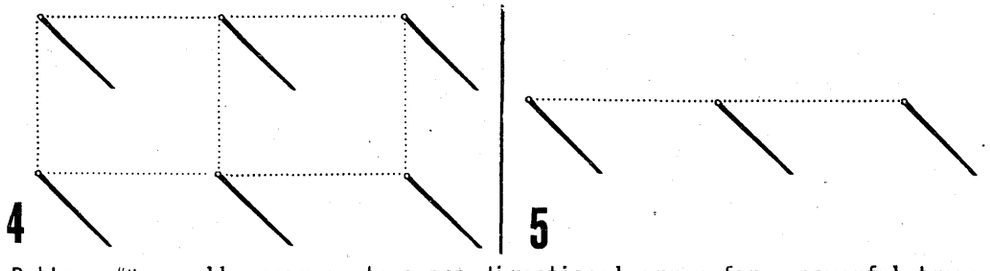
Patterns in vertical photographs are important insofar as they indicate directional capacities and probable use. Certain directional patterns of masts indicate Direction Finding or Navigational Aids, which removes the installation from the category of communications.

A single mast is non-directional.

Note: Dotted lines are to show form of pattern and do not necessarily represent location of antennae. Arrow indicates direction(s) of radio "beam".

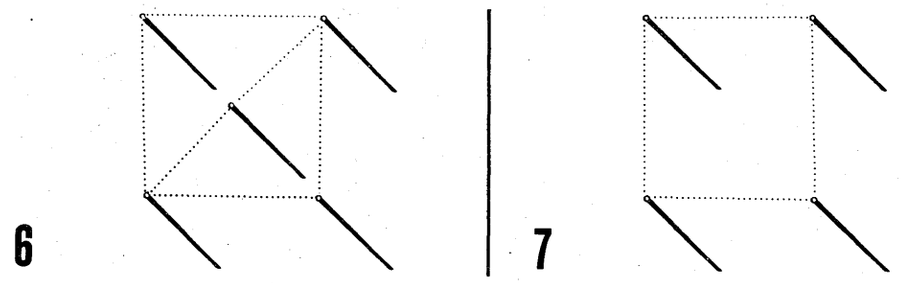


Patterns #1, #2, and #3 represent non-directional Radio Communications. Although it may be possible to achieve directivity from these patterns, particularly #1, they are much more likely to be used for non-directional communications and constitute the most frequently found patterns for communication stations.



Pattern #4 usually represents a non-directional array for a powerful transmitter. However, it can be directional (on long or short axis) if spaced and fed for that purpose.

Pattern #5 can represent directional high frequency transmission, if masts are spaced close together ($\frac{1}{2}$ wave length).



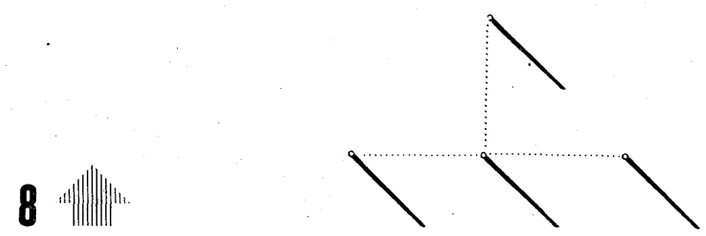
Patterns #6 and #7 are examples of arrangements that are likely to create difficulties in interpretation:

#6, with a diagonal dimension of approximately 600 feet is likely to be a radio range station capable of sending a navigational beam in any prescribed direction. This is not a communications pattern.

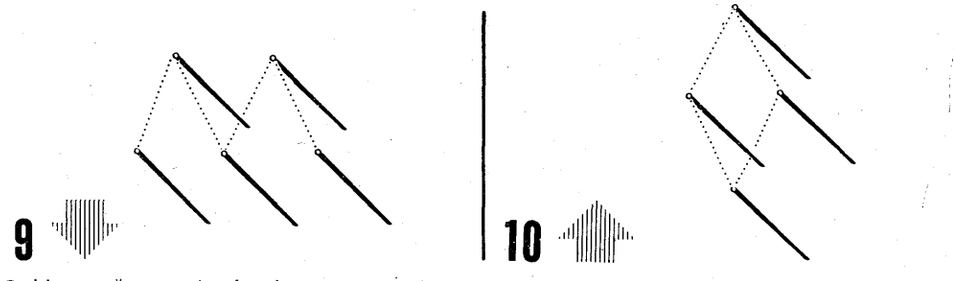
#7 is either a communication station pattern or a direction finder pattern.

(a) If Communications, the size will be a clue. The diagonal dimension will then be from several hundred to two thousand feet. Large auxiliary buildings, housing transmitter, power house, offices and personnel quarters will be visible.

(b) If a Direction Finder, the diagonal dimension will be approximately 100 feet. In Japanese design there is likely to be a small shack in the exact center of the pattern, but this is not absolutely necessary. Diagonal underground cables are usually visible.



Pattern #8 represents a communications station which may be directional as shown by arrow.



Pattern #9 used singly or repeated may indicate a navigational aid, either for ships or aircraft. Such an arrangement is also used for intercept purposes; for directional communication, 2 masts may be at point of "V".

Pattern #10 indicates directional communications and is called a "rhombic" pattern. It usually occurs in multiple units, radiating from a central point.

Such a pattern is used with HF or VHF transmitting gear or may support receiving antenna.

MAST HEIGHTS

Heights of masts are the best indication of the frequency and range of the radio installation. This is true because it is desirable to raise the antennae, and, thus, the feed wire which transmits, as far off the ground as possible for best operation. By relating the height to the number and type of mast, it is possible to estimate the station capacity by fairly logical means.

IN GENERAL

High Mast = low frequency = long wave = long range
Low Mast = high frequency = short wave = short range

The following table will be helpful in estimating frequencies and ranges from masts visible on aerial photographs.

JAPANESE RADIO COMMUNICATIONS, MAST-FREQUENCY RELATIONSHIP
FIXED INSTALLATIONS

	FREQUENCY	NO. MASTS	MAST HEIGHT	FREQUENCY IN MEGACYLES PER SEC.	WAVE LENGTH	*** USUAL OPERATING RANGE
STICK MASTS	*VERY HIGH (LINE OF SIGHT)	1	GERMAN DECIMETRE STATIONS HAVE 160' MASTS	30 TO 300 MCS (50 TO 100 LIKELY)	10 TO 1 METER	75 MILES
	HIGH	1 TO 3	WHIP ANTENNAE OR VERY SMALL STICK MASTS	3 TO 30 MCS	100 TO 10 METERS	****200 MILES
	MEDIUM**	2 OR MORE	50' TO 75'	0.3 TO 3 MCS	1000 TO 100 METERS	500 MILES
LATTICE MASTS	MEDIUM**	2 OR MORE	60' TO 100'	0.3 TO 3 MCS (300 TO 3000 KCS.)	1000 TO 100 METERS	500 MILES
	LOW	2 OR MORE	100' TO 500' (125' TO 300' MOST LIKELY)	0.03 TO 0.3 MCS (30 TO 300 KCS)	10,000 TO 1000 METERS	1000 MILES
	VERY LOW	3 OR MORE	400' TO 800' STICK OR LATTICE	10 TO 30 KCS	30,000 TO 10,000 METERS	5000 MILES

* Although there are many types of V.H.F. antennae in connection with portable, mobile, and airborne equipment, no fixed Japanese installations have been seen as yet which operate at such high frequency.

** Most used for land based communication stations.

*** Very rough figures, dependent on many factors.

****When utilizing sky waves, H.F. can transmit over long distances (beyond 1000 miles) on any height of mast.

Estimates of frequency in the following pages are based on the lowest frequency, and auxiliary higher frequency transmitters should be presumed to be present.

Rule of thumb method to determine wave length: Approximate wave length (in meters) 4 x mast height (in meters).

RANGE

1. Some factors which affect range are transmitter power, time of day, weather, time of year, sun spots, and receiver sensitivity.
2. A single steel lattice mast may sometimes be used as a radiating mast and its range would be less than normally expected of its height because of electrical difficulties in transmitting in this manner. In this case the station must operate on a limited fixed frequency and cannot be directional.
3. Many masts imply many channels of communication and do not necessarily mean added range.
4. Siting of masts on or near water gives added range.

SPACING

Spacing between masts in communications is not very important electrically, as is the case in Direction Finding and Navigational Beam installations.

However, due to the mechanical difficulties of supporting antennae in long spans, it can be assumed that the longer the span (or distance between masts) the more powerful the transmitter, for it would not be economically wise to build equipment in excess of the needs of the power of the transmitter.

By this reasoning, for example, a spacing of 500-600 feet would imply that a low frequency transmitter of considerable power were present.

[redacted]

COMMUNICATIONS

SUMMARY (CONT.)

BASES

Bases of lattice masts consist of three or four legs, set in square blocks of concrete which often show up clearly in aerial photos. (Occasionally the concrete bases of stick masts are visible)

It is quite possible to determine, very roughly, the height of the lattice mast by the distance between legs at the base. (this table for Japanese masts only).

Distance between legs.			Height of Mast.		
10	-	20	60'	to	75'
20	-	30	75'	to	125'
30	-	45	125'	to	200'
45	-	65	200'	to	300'

However, it is recommended that shadow or parallax measurements be used to determine height wherever possible.

PLATFORMS

Most Japanese lattice masts of recent design incorporate a relatively elaborate system of platforms near the top, triangular and rectangular in shape, ranging in size from 25 square feet to 125 square feet in floor area.

These platforms occur singly and in twos and threes. In a three mast station, identical platforms are found in each of the three masts.

NAMUR

PALAU

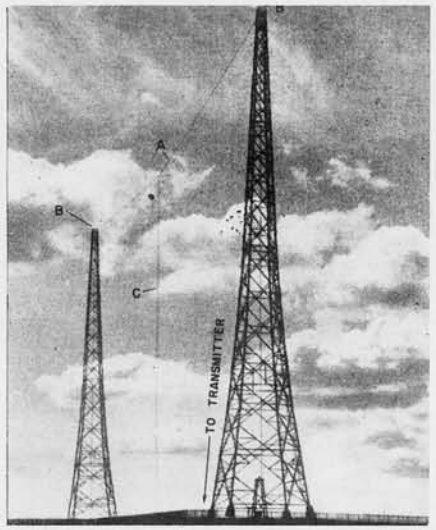
PROBABLE USES

a. Observation. In many cases no other observation towers are present.
b. Warning devices. Note siren in photo. (left above)
c. Light Beacons.
d. Visual Signals - The Japanese now possess, in addition to the usual blinker light signaling systems, equipment of German design which can send blinker or voice and may use infra-red light. The range is approximately eight miles and is not vulnerable to the usual jamming methods.
e. Antennae. It is possible but not determined by ground information, that certain platforms on low and medium frequency masts may contain high or very high frequency whip antennae or dipoles.

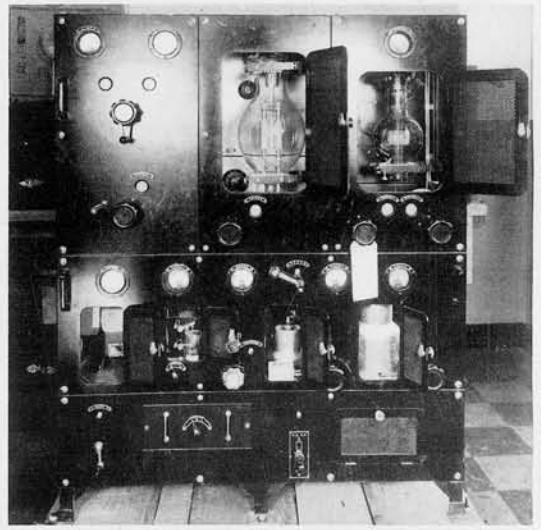
TRANSMITTERS

1. The transmitter is the most vital installation in a communications set-up and is usually found within 300 feet of the masts. It is possible that the communications office may be separated from the transmitter but the latter will be near the masts nevertheless. Generally they are grouped together, however. (See "Communications Centers").
2. Range increases as the square root of the increase in transmitter power. Example: 4 times the power = 2 times the range.

With this in mind, it can be readily seen that tremendous additional power must be used to establish reliable communications beyond the range for which the station was designed.



"A" - Antenna, "B" - Insulators, "C" - Feed



MEDIUM FREQUENCY TRANSMITTER

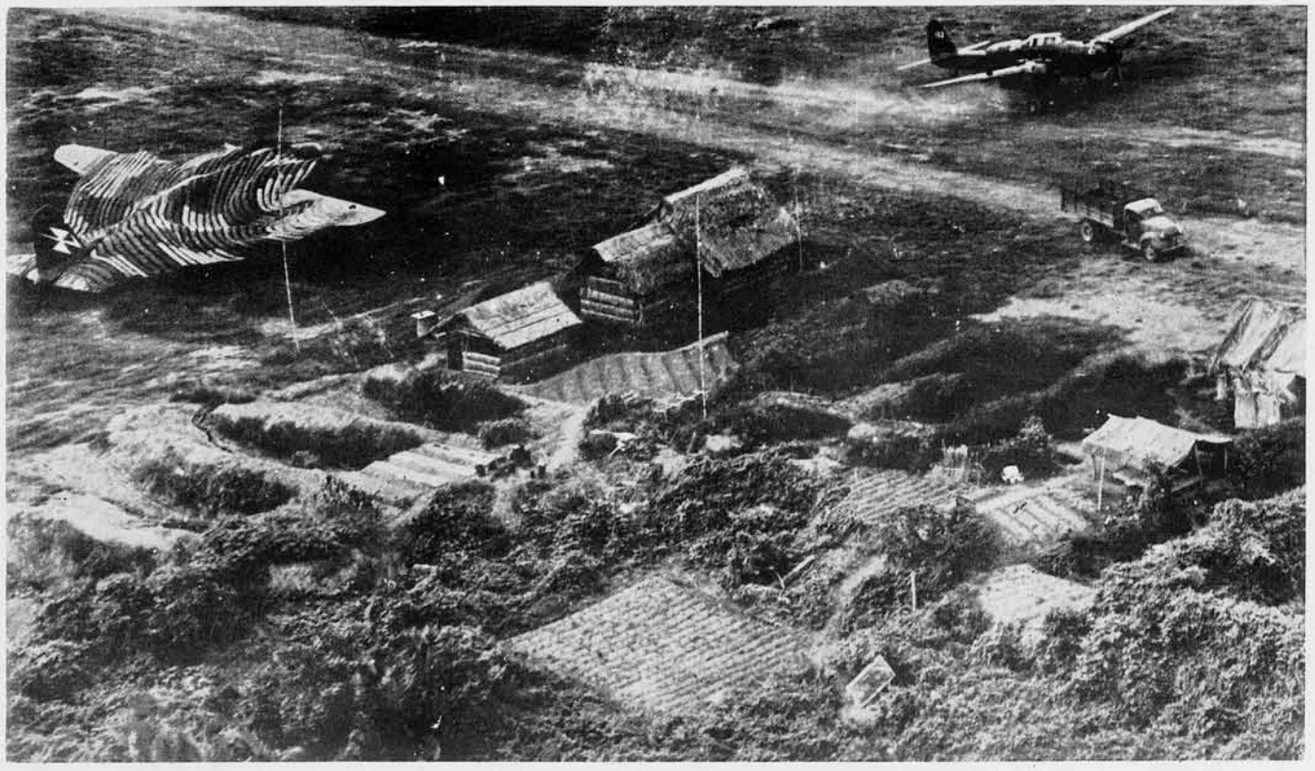
Receiving stations are often found some distance away from transmitting stations, and have their own masts and antennae.

PHOTOGRAPHIC INTERPRETATION REPORTS

In writing reports on Radio communication installations, it is desirable to mention the following:

1. Probable frequency of station.
2. Probable use of station.
   Example: (a) Communication Center
   (b) Weather Station etc.
3. Probable geographic area of range.
   (a) Important geographic connecting points (for medium frequency stations, particularly).
   (b) Other known stations within range.
   (c) Directional capabilities, if any.
4. Pattern of masts, especially if installation suggests a possible Direction Finder or Navigational Aid.
5. Location of transmitter and generator buildings.

COMMUNICATIONS
HIGH FREQUENCY



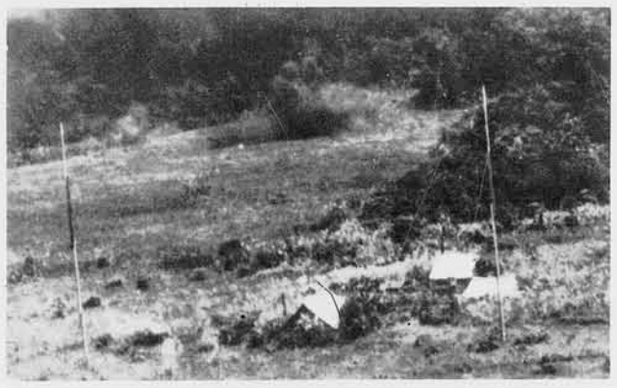
3 MAST-HIGH FREQUENCY

ABOVE: Ground to plane communication. Japanese High Frequency aircraft band is approximately 5 to 10 Mcs. High Frequency Radio Communication is not used by the Japanese for large land based stations except as a supplementary transmission. It is used as follows, (except for long range sky wave of approx. 10 mcs.)

(a) Near airports for communication with pilots in the air or on the runway
(b) Small well-hidden stations for short distance communications between commands
(c) Semi-portable, portable, mobile, and walky-talky sets for the ground troops, A/A batteries etc.

All of these types are extremely difficult to pick up on aerial photographs.

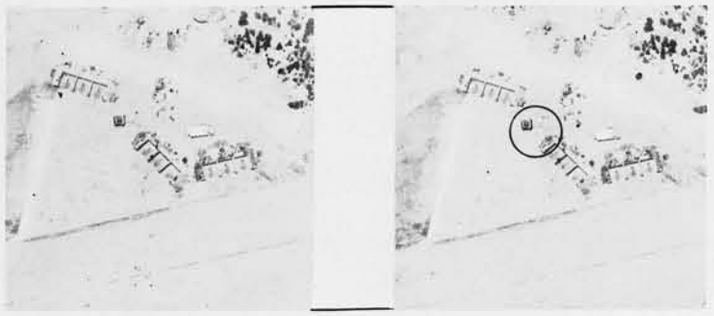
Mast arrangement may assume a variety of forms but is likely to be made up of small, flimsy wooden stick masts or whip antennae.



2 MAST-HIGH FREQUENCY

LEFT: Probable High Frequency Field Radio Station with transmitter and receiver housed in tents. This type of station may be interpreted with good photography at scales of 1/10000 or less.

Insufficient information is available on the use of Very High Frequency (V.H.F.) fixed installations by the Japanese. No transmitters of this frequency have been captured. V.H.F. can be used for portable transmitters, aircraft communications, and point to point communications over short distances (up to 75 miles). The German "Decimeter Stations" (which are 30 miles apart) are an example of the latter use.

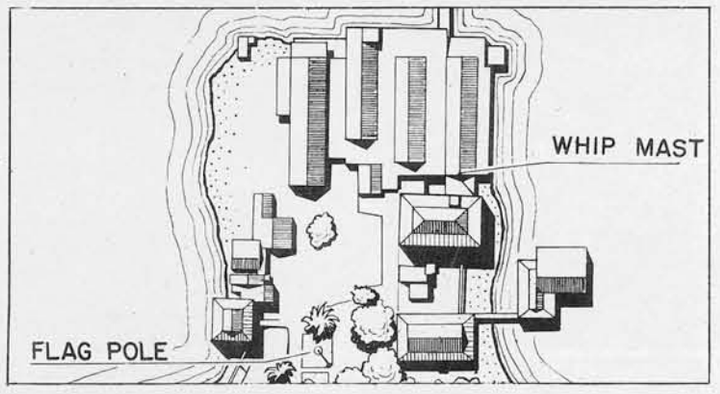


SINGLE MAST-HIGH FREQUENCY (R.F. - 1/7500)

ABOVE: Another example of ground to aircraft communication. This may be a type of stick mast or whip antennae carrying High Frequency messages for use of control tower at airport. Radio operates at 3-30 Mcs. This mast may be called a "whip antennae".

(R.F. - 1/2500)

WHIP ANTENNAE - HIGH FREQUENCY



ABOVE: Stereogram and sketch of whip antennae mounted on top of warehouse building. Such a station is often impossible to spot in aerial photographs, except when coverage is unusually low and photos are good. High Frequency transmitters are normally used for Communications over distances of less than 200 miles.

COMMUNICATIONS

MEDIUM FREQUENCY

Most Japanese communication stations fall in the Medium Frequency band (0.3 to 3 Mcs.). These stations take on many forms. The typical military communications center with a somewhat standardized concrete building and three 75 feet high lattice masts is already familiar to interpreters. Examples of these are shown under "Communication Centers".

In addition, a less standardized use of spliced stick masts with associated buildings of various designs and adaptations, is widely employed for medium frequency antennae in advanced areas.

Some stations, classified as "Medium Frequency" on these pages, probably overlap into the "Low Frequency" band. International standard breakdown and nomenclature is used for classifications throughout this report.

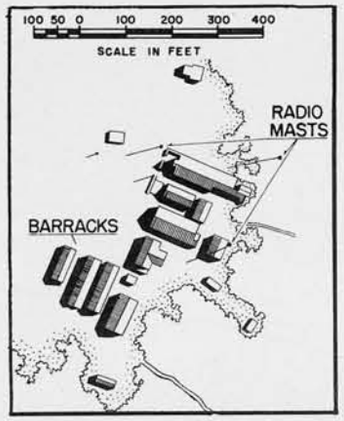
In the more built up land areas captured by the Japanese and on Japan itself will be found many peacetime broadcast stations operating in the medium frequency band as well as stations associated with airfields and industry. All of this latter group are likely to employ lattice masts.

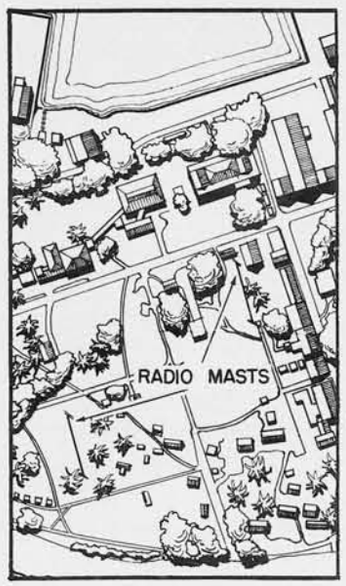
In this section, many examples of various types are shown and salient information and dimensions, as may be obtained from aerial photographs, are presented. Ground information is not yet available on most of the installations shown, so it is best not to regard any specific interpretation as the final word, but, rather, to utilize the benefits of a reference collection and an interpretation approach.

On this page are shown two Medium Frequency Communications Stations utilizing stick masts.

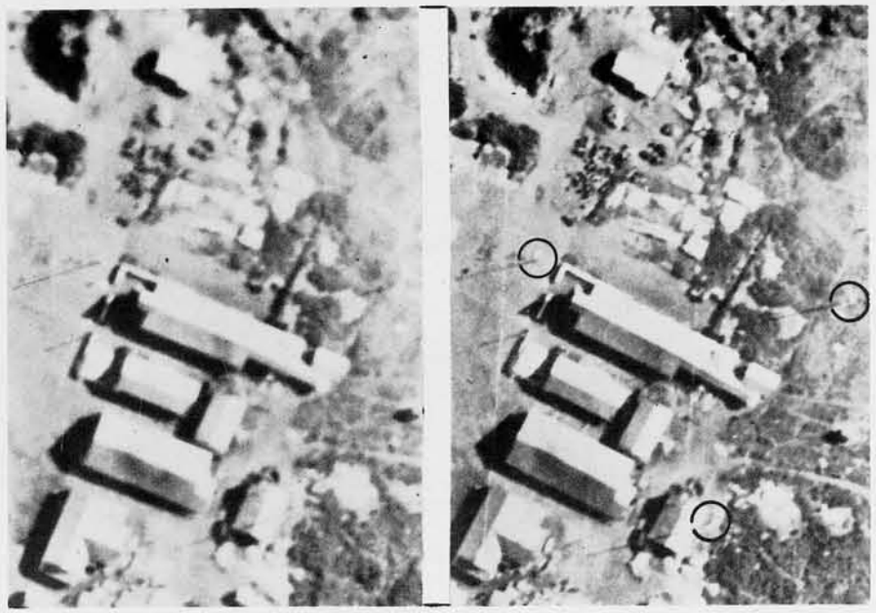
JALUIT: Masts over 100 feet high and 425 feet apart are excessive for Medium Frequency. However, it is unlikely that Low Frequency antennae would be carried on this type of stick mast. It is quite possible that this station will include the upper part of the Low Frequency band, as well as lower part of the Medium Frequency.

ARAIDO: Three Medium Frequency stick masts, 60 feet high, arranged in a near isoceles triangle pattern.

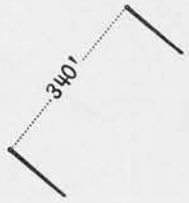




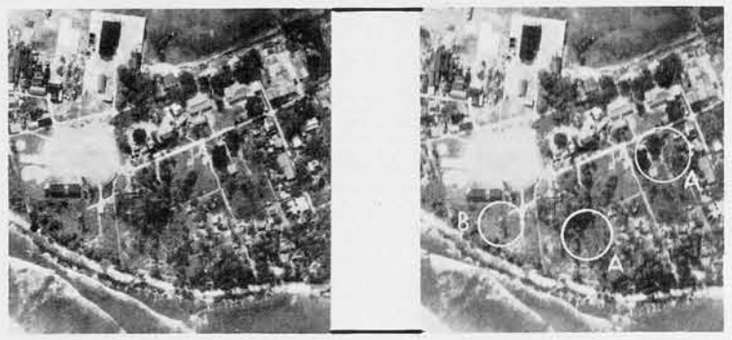
JALUIT, MARSHALLS (R.F. - 1/42500)



ARAIDO, KURILES (R.F. - 1/2000)



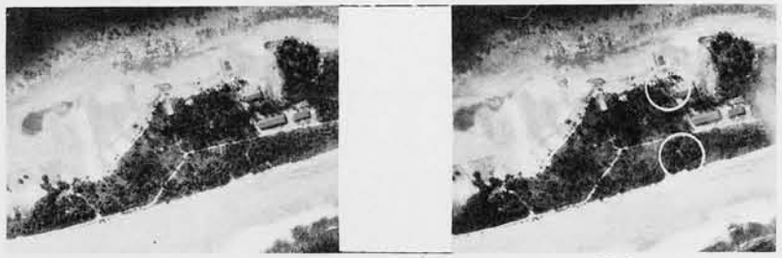
RIGHT:
"A" - 100' stick masts.
"B" - observation tower.



JALUIT, MARSHALLS (R.F. - 1/6750)

CONFIDENTIAL

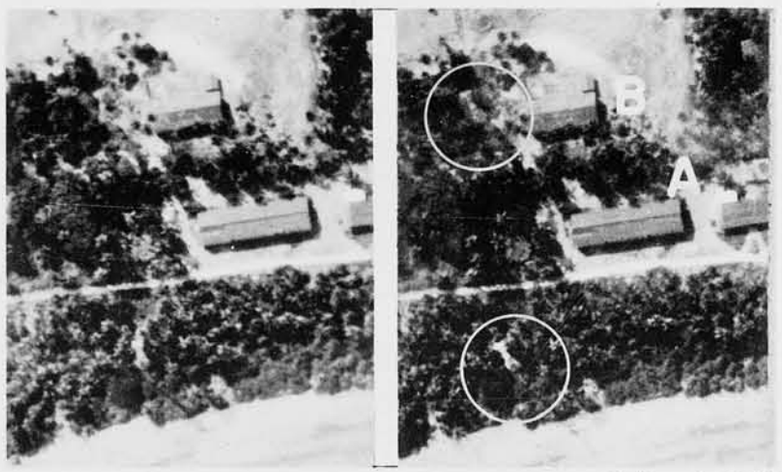
COMMUNICATIONS
MEDIUM FREQUENCY (CONT.)



(R.F. - 1/12000)

JALUIT, MARSHALLS

Medium Frequency Station at Jaluit has two lattice towers, approximately 75 feet high, spaced 350 feet apart.

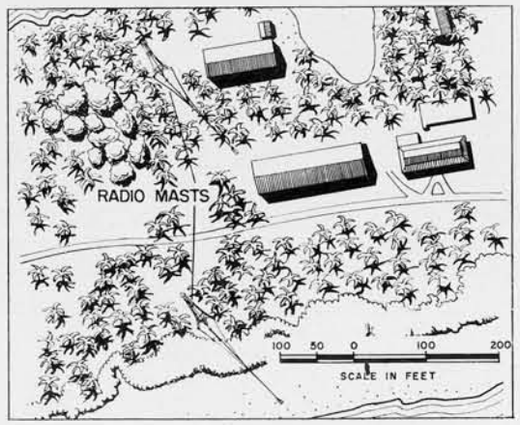


(R.F. - 1/3200)

JALUIT, MARSHALLS

Three masts, of steel lattice design with platform, are L-6 type.

The transmitter is probably at "A"; the power is probably at "B".



350'

JALUIT, MARSHALLS

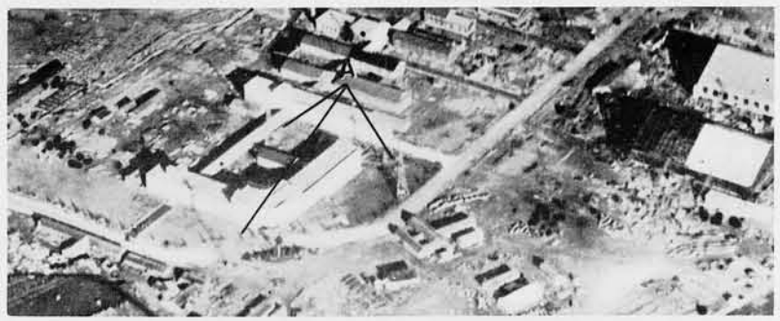
210'

(R.F. - 1/4000)

PALAU

Steel lattice masts at Palau, approximately 75 feet high, are for Medium Frequency Communications. Water siting offers better ground. Type L-6.

375' ±



HOKKAIDO, JAPAN (BIHORO)

300'

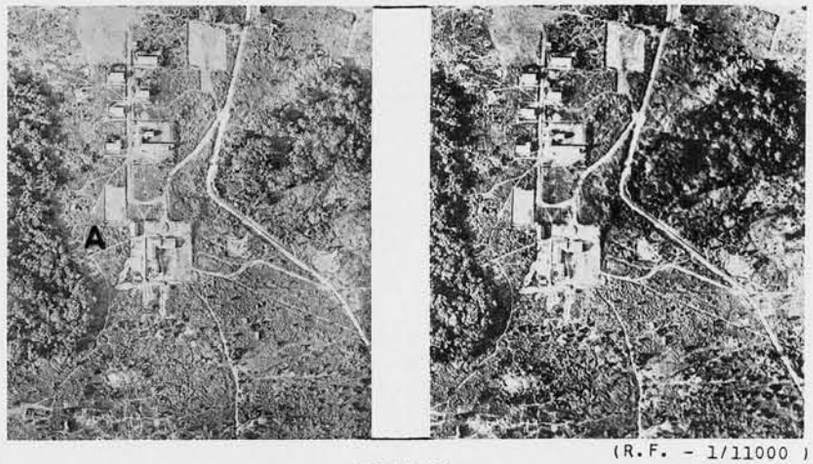
HOKKAIDO, JAPAN (CHITOSE)

The two examples above (Bihoro and Chitose) show Medium Frequency lattice masts in connection with Japanese industrial plants and airfields. Masts are type L-6.

Lattice masts (A) are 100 feet or less in height, which indicates probable Medium Frequency - but fairly powerful stations.

CONFIDENTIAL

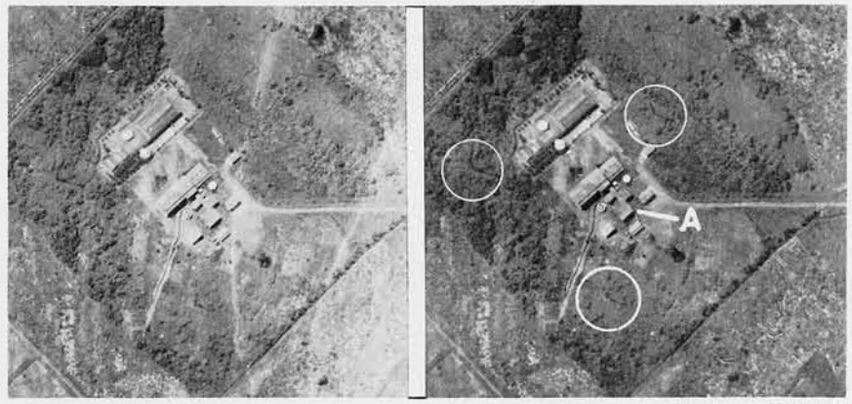
COMMUNICATIONS
MEDIUM FREQUENCY (CONT.)



(R.F. - 1/11000)

PALAU

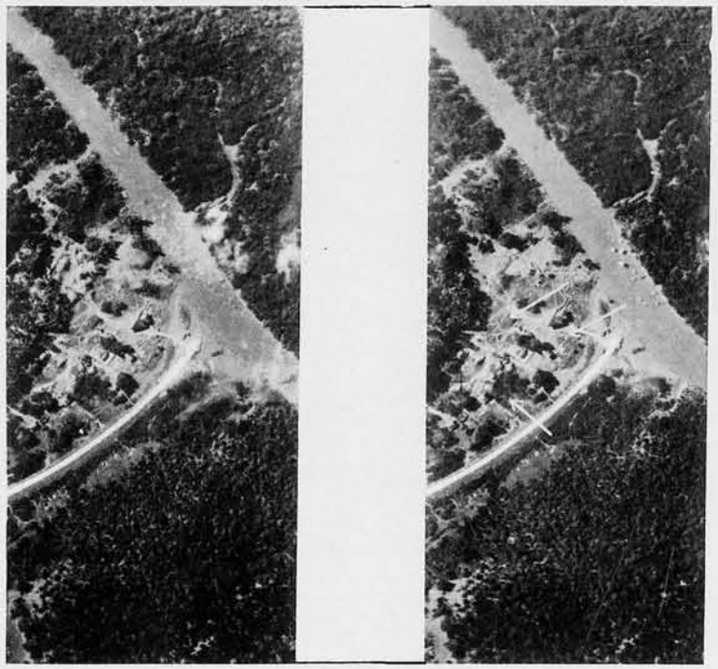
Probable Medium Frequency lattice masts, type L-6. This arrangement is unusual in that the towers do not appear to be related to a transmitter building for convenient direct feed wire connection. Note power or telephone line at "A". This is a border-line example and could be Low Frequency or a powerful Medium Frequency Station.



(R.F. - 1/4500)

PONAPE, CAROLINES

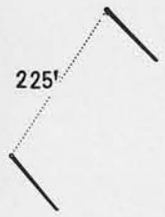
Medium Frequency station with three type S-5 stick masts. Transmitting building is at center of three masts. Power is at"A" (Note proximity of water cooling building). Building at top is a barracks. A station of this size frequently has lattice masts.

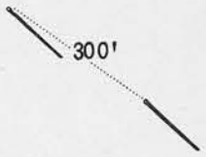


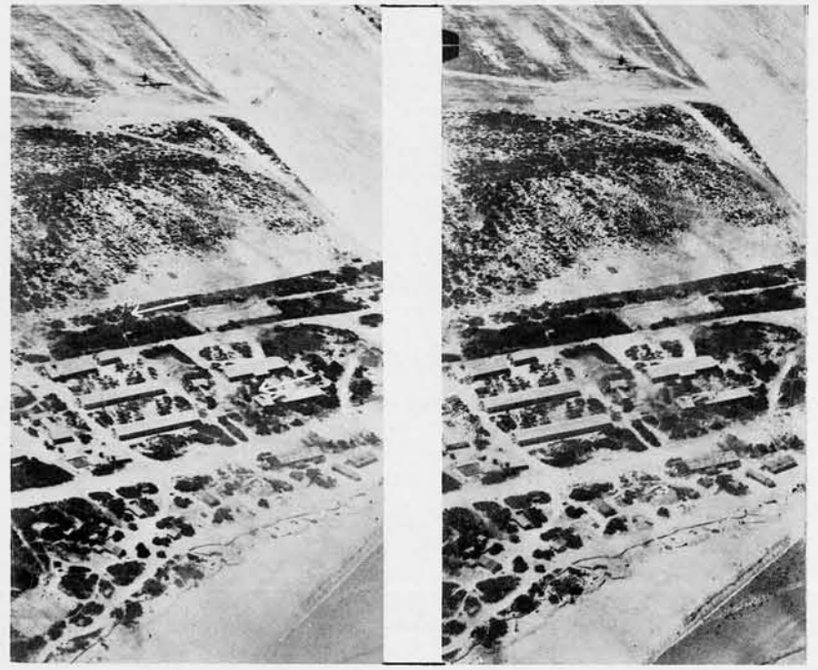
(R.F. - 1/5500)

BURMA

Existing trees might be used effectively to camouflage a radio installation. In this example palms appear to be used as masts for support of Medium Frequency antennae.



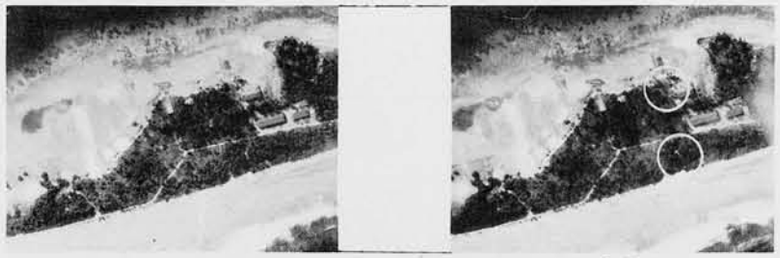




WAKE

Stereo-oblique of Medium Frequency station with 60' type S-1 stick masts. Transmitter appears to be buried.

COMMUNICATIONS
MEDIUM FREQUENCY (CONT.)



(R.F. - 1/12000)

JALUIT, MARSHALLS

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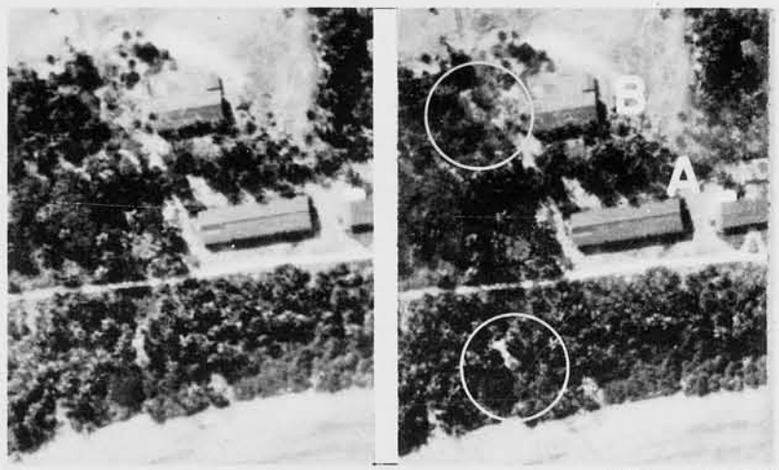


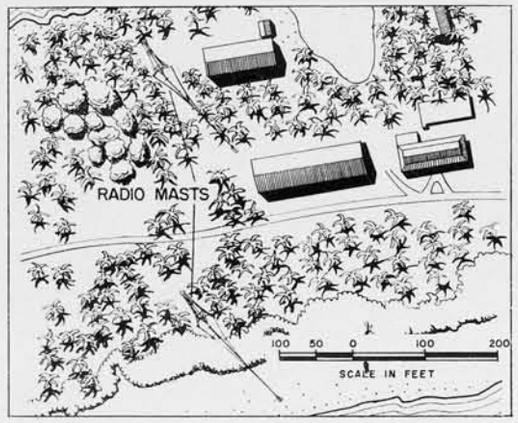
(R.F. - 1/3200)

JALUIT, MARSHALLS

Three masts, of steel lattice design with platform, are L-6 type.

The transmitter is probably at "A"; the power is probably at "B".

350'



JALUIT, MARSHALLS

210'

(R.F. - 1/4000)

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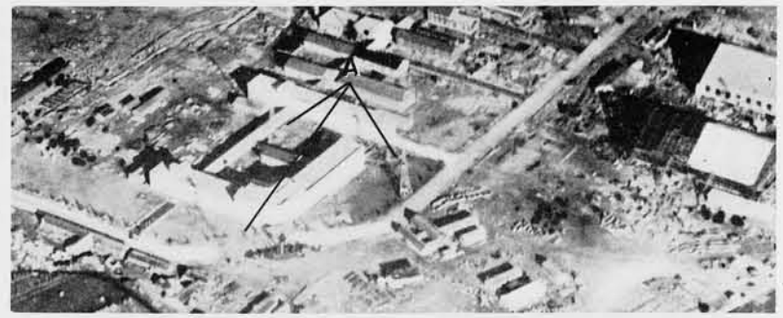

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300'

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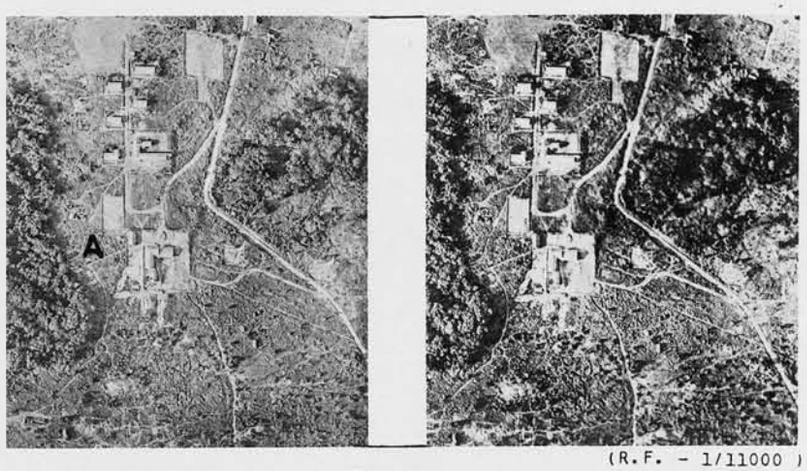
CONFIDENTIAL

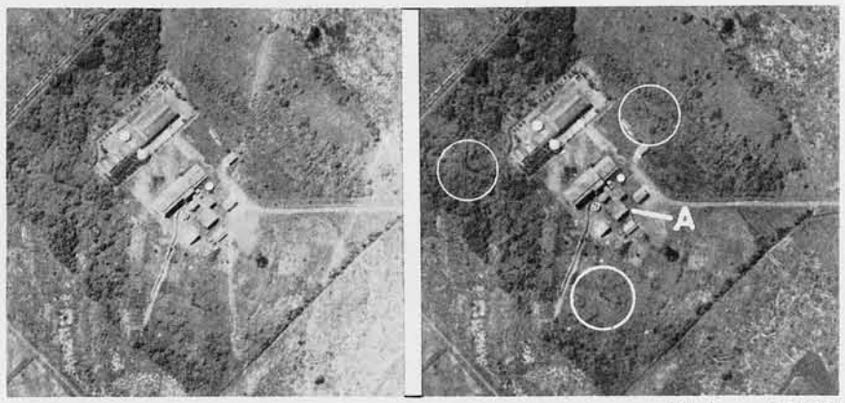
COMMUNICATIONS
MEDIUM FREQUENCY (CONT.)



(R.F. - 1/11000)

PALAU

Probable Medium Frequency lattice masts, type L-6. This arrangement is unusual in that the towers do not appear to be related to a transmitter building for convenient direct feed wire connection. Note power or telephone line at "A". This is a border-line example and could be Low Frequency or a powerful Medium Frequency Station.



(R.F. - 1/4500)

PONAPE, CAROLINES

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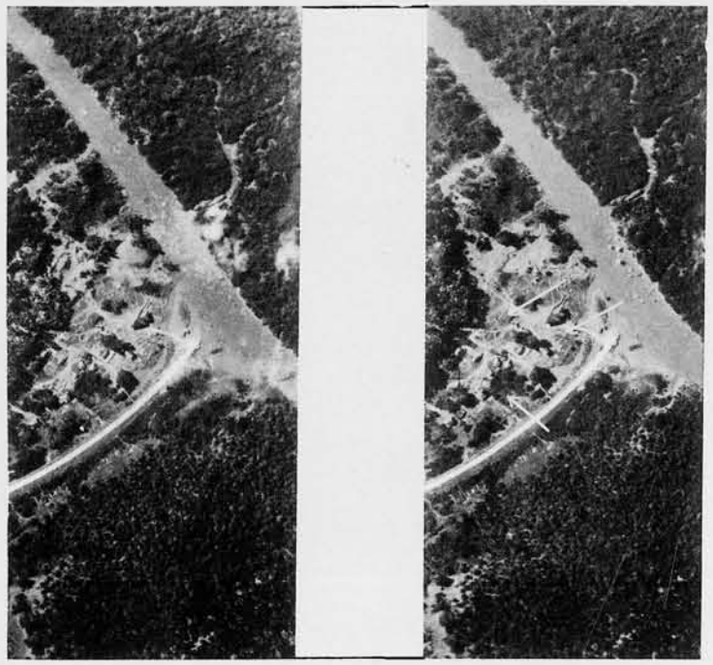

(R.F. - 1/5500)

BURMA

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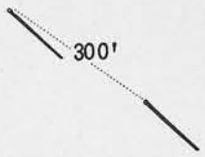
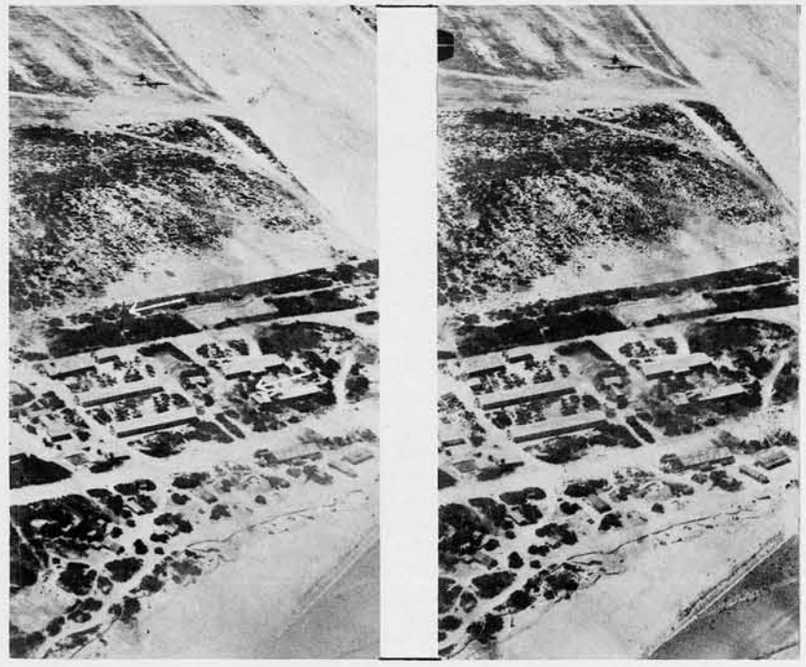
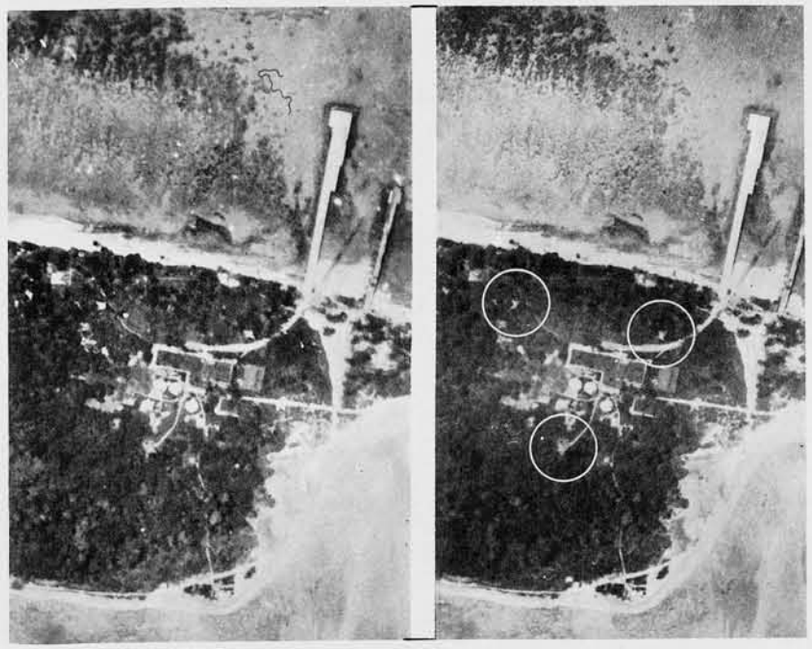




WAKE

Stereo-oblique of Medium Frequency station with 60' type S-1 stick masts. Transmitter appears to be buried.

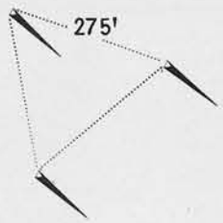


(R.F. - 1/4300)

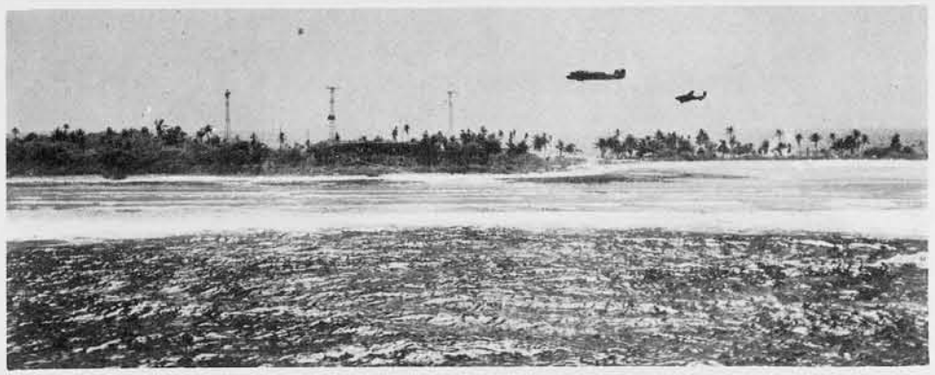
PIGEEYATTO, MALOELAP, MARSHALLS

"A" - Two of the three 75' high lattice masts.

"B" - Platform and signal light.

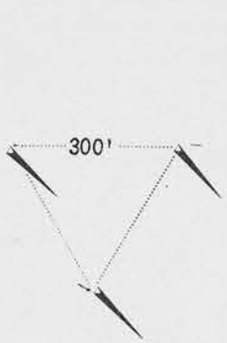


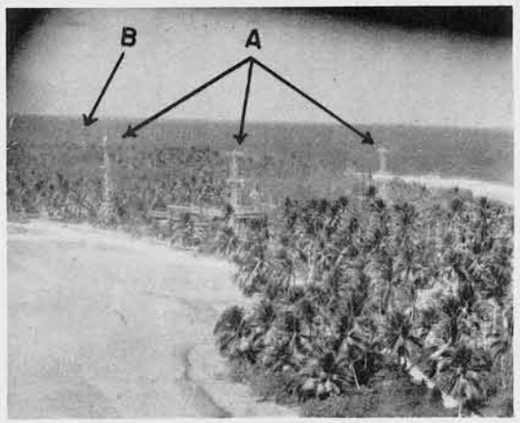
PIGEEYATTO, MALOELAP, MARSHALLS



PIGEEYATTO, MALOELAP, MARSHALLS

ABOVE: The station on Maloelap is introduced here as a typical example of the standard Medium Frequency communications building and arrangements of mast as shown in "Communications Center" section. This design is a favorite of the Japanese throughout their island bases. The lattice masts are usually 75 feet high arranged in an equilateral triangular pattern with 150 to 300 feet sides.

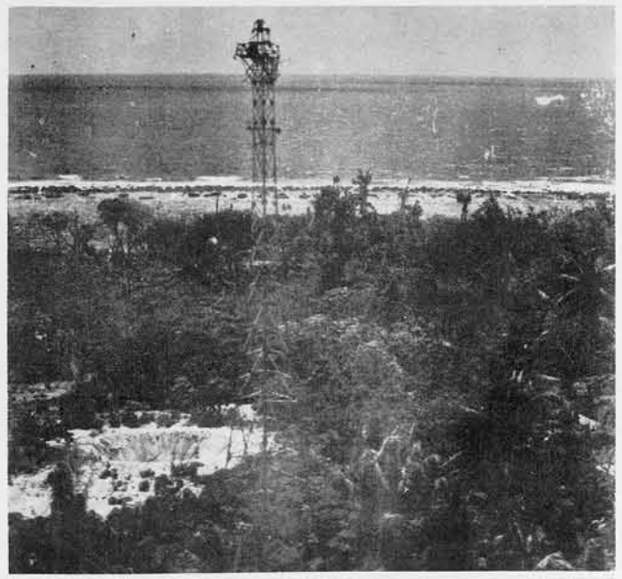




JALUIT, MARSHALLS

Medium Frequency communications center at Jaluit, which is similar to Maloelap.
"A"-THREE LATTICE MASTS - 75 FEET HIGH; "B"-OBSERVATION TOWER.

PIGEEYATTO, MALOELAP, MARSHALLS



PIGEEYATTO, MALOELAP, MARSHALLS

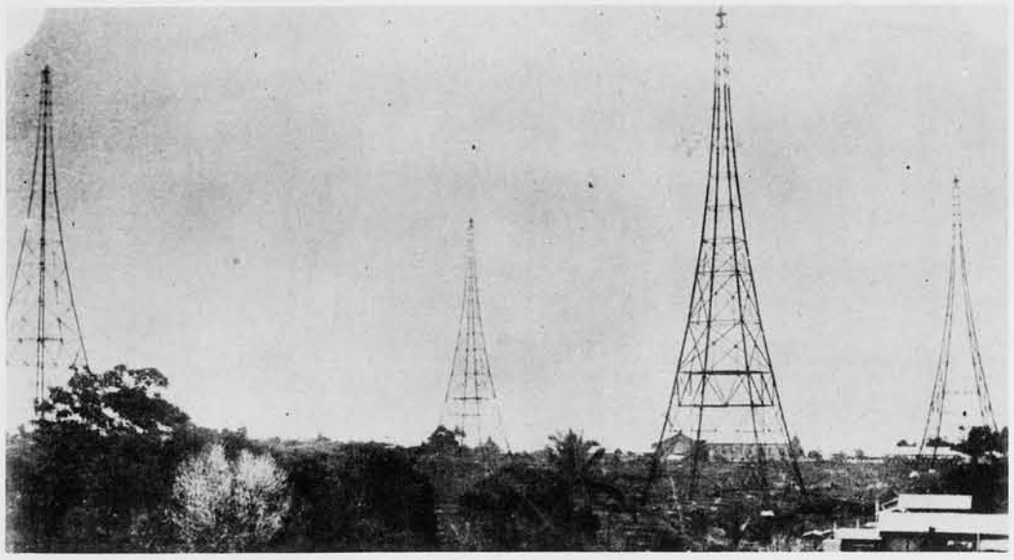
COMMUNICATIONS

LOW FREQUENCY

The stations shown here under "Low Frequency" include "Very Low Frequency" and some that may be unusually powerful "Medium Frequency" stations, which would have added range.

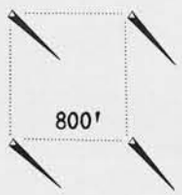
Irrespective of exact determination of frequency, which is often very difficult, it is important to refer to installations such as shown on these particular pages as powerful, long range stations in the lower frequency band.

The most powerful Communications Stations are likely to be Low Frequency and are more often found in the Inner Empire, and in other well-populated conquered areas.



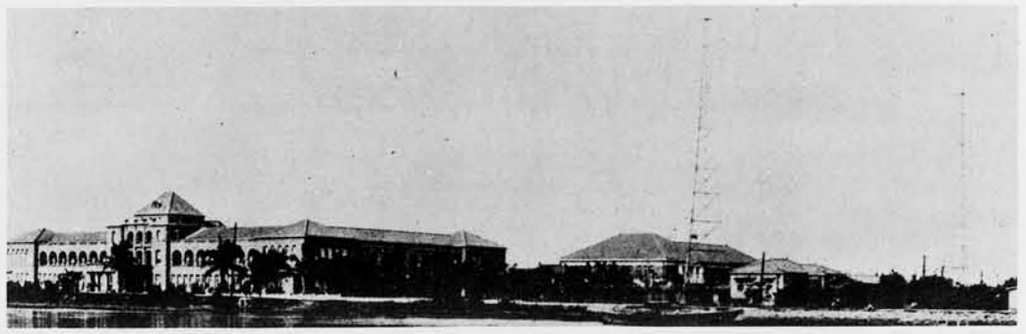
KOROR, PALAU

View of Koror Radio Station taken in 1926. At this time the station operated on several frequencies, including low, and could communicate with Japan. The masts are 300 feet high and arranged in a square pattern, 800 feet on a side.



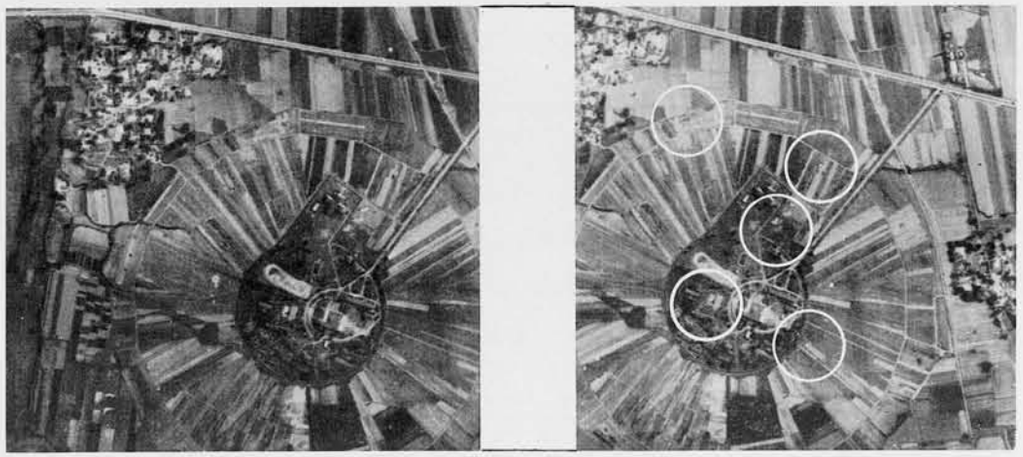
KOROR, PALAU

Same station at Koror taken July 1944. This installation is also included under Navigational Aids because its pattern and dimensions indicate such a capacity in addition to communications.



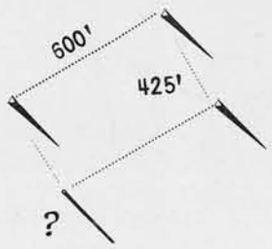
TAKAO, FORMOSA

Low Frequency lattice masts adjacent to Provincial Office Bldg., Takao, Formosa.



TAKAO, FORMOSA (R.F. - 1/16400)

The Hozan Station at Takao is one of the largest and most powerful in Japanese possession. The five lattice masts are 350 feet or more in height. The cross-shaped building appears to be a recently constructed transmitting and administration center. The heavily revetted building probably houses the main transmitter, which may include Low Frequency. Masts are spaced 800' - 1000' The circular and radial patterns seem to be a result of tuning houses which are set up on the outside diameter. These houses are 15 feet square and are arranged in groups of threes (in equilateral triangles); they number 54 in all.



TAKAO, FORMOSA (R.F. - 1/16400)

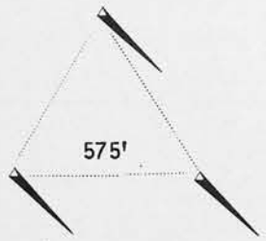
Another probable Low Frequency Station at Takao. Two lattice masts are 125 feet high; two are 90 feet high. Transmitter is in large central building.

Takao has several high powered Radio Communication Stations.

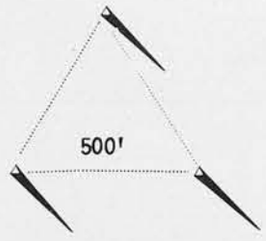
BANKOK, THAILAND (R.F. - 1/17700)

Low Frequency station at Bankok with 225 foot high lattice masts. Transmitter building has dark tone on roof.

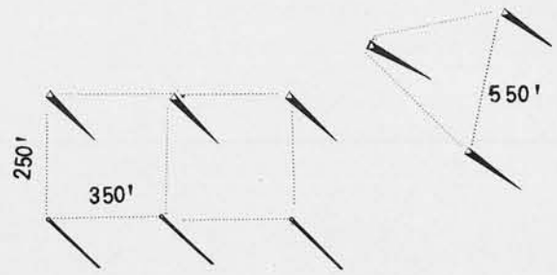
BABELTHUAP, PALAU (R.F. - 1/7500)



BANKOK

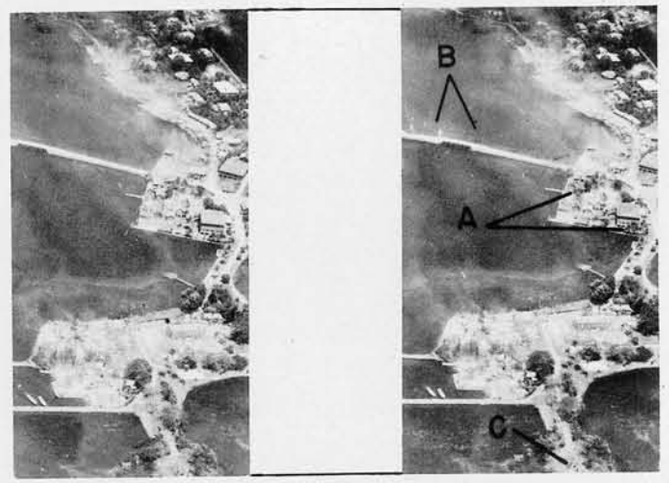


YAP



PALAU

LEFT: Six lattice masts and three stick masts support Low Frequency antennae at this large station on Palau. (See page 2.17) The numerous small stick masts that are present do not show up in this vertical. Cross-shaped building is probably housing for one or more transmitters. All masts shown are between 150 feet and 225 feet in height.

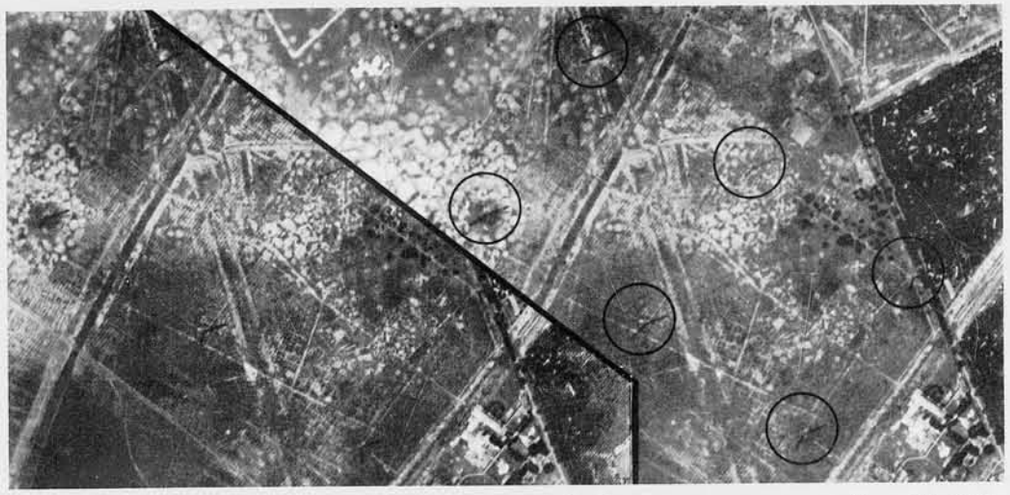


YAP

YAP

"A" - 125 FEET HIGH - LATTICE MASTS.
"B" - TRANSMISSION LINES.
"C" - 60 FEET HIGH SPLICED WOOD STICK MAST.

This station at Yap is probably Low Frequency. The masts are in a triangular pattern with the large, three-storied building in the center (probably housing for transmitter).



SAIGON, F. I. C. (R.F. - 1/13500)

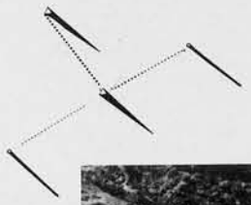
Powerful Low Frequency or Very Low Frequency station under construction at Saigon, French Indo China. This arrangement of high stick masts apparently erected for supporting triatrics, is a typically French design. (Note Bourges Station under "German").

COMMUNICATIONS
LOW FREQUENCY (CONT.)

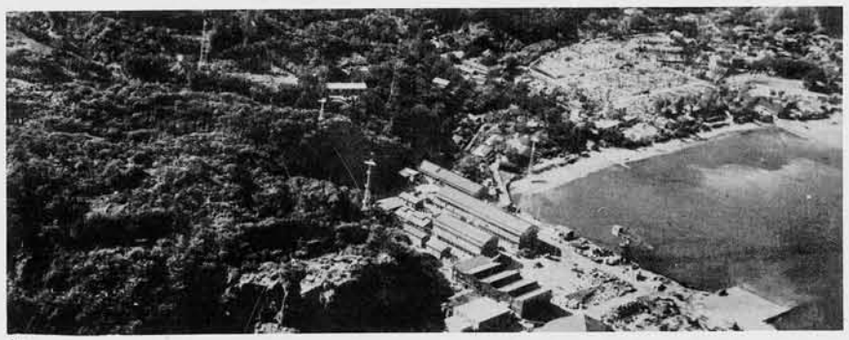
TOKYO, JAPAN

Three lattice masts of a pre-war Low Frequency Station in Tokyo. These masts are about 250 feet high and arranged in an equilateral triangle with 500 to 600 foot sides.

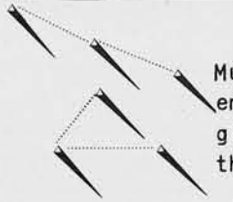
PARAMUSHIRO (R.F. - 1/9000)



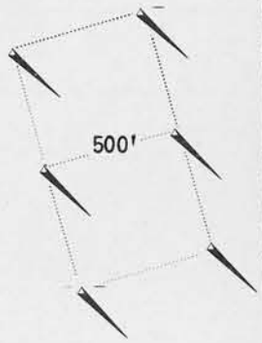
Night photo of station at Surabachi Wan, on the east coast of Paramushiro. The masts, two lattice and two stick, are arranged in a "T" form with the bottom of the "T" pointing toward Tokyo. This station may be directional.

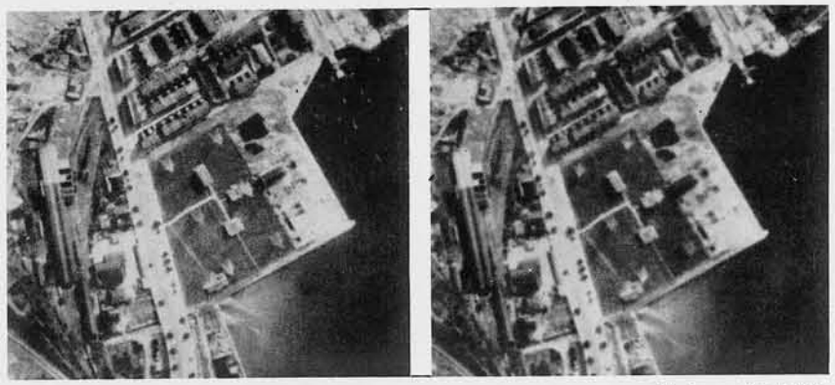


CHICHI JIMA, BONIN IS.



Multi-mast Low Frequency Station at northern end of Chichi Jima. Note effect of hilly topography on design of lattice masts. Note also the seaplane base.





(R.F. - 1/1000)

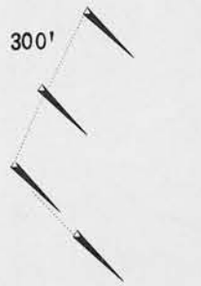
KOWLOON, CHINA

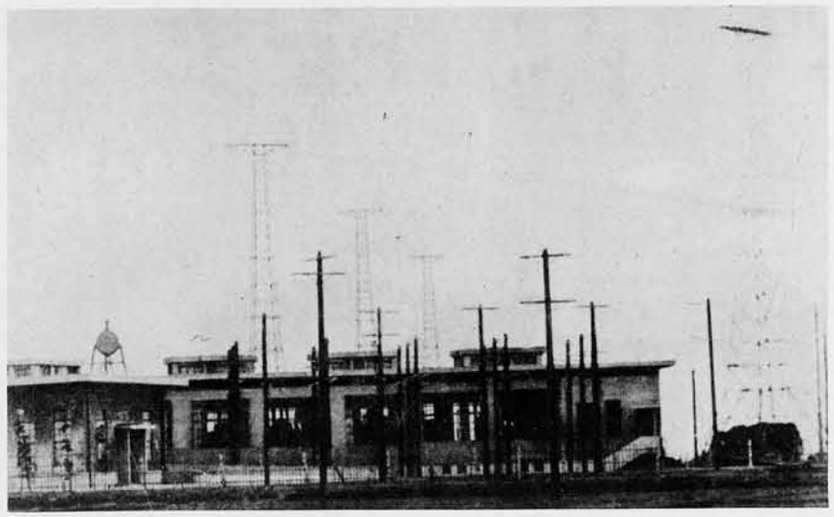
Pre-war British broadcast station at Kowloon, near Hong Kong, now being operated by the Japanese.

(R.F. - 1/15200)

PESCADORES IS.

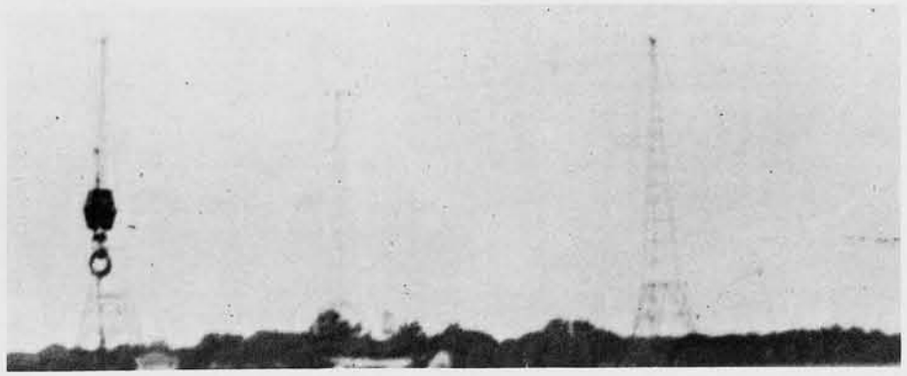
Medium or Low Frequency Station. Two lattice masts, 100 feet or more in height, are supporting the antennae. This installation appears to be of fairly recent construction.





YOSAMI, HONSHU, JAPAN

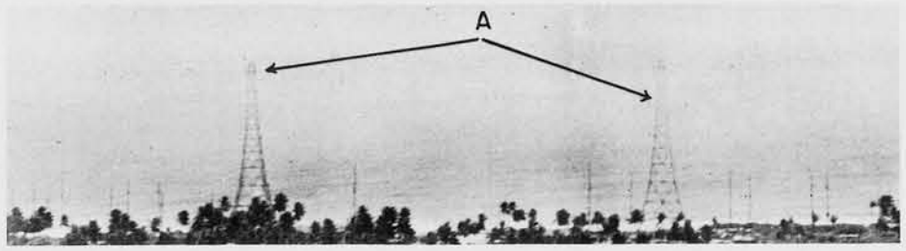
The Yosami station is a Japanese pre-war communications center and broadcasting station.



CAVITE, PHILIPPINES

Above and to the right are views of a Very Low Frequency military station, constructed by the U. S. at Cavite. Although there are now but two masts left of the original three, the Japs appear to have reconstructed and are now using this station.

The masts are 600 feet high, which is taller than any masts of Japanese design yet discovered outside of Japan proper.



KWAJALEIN

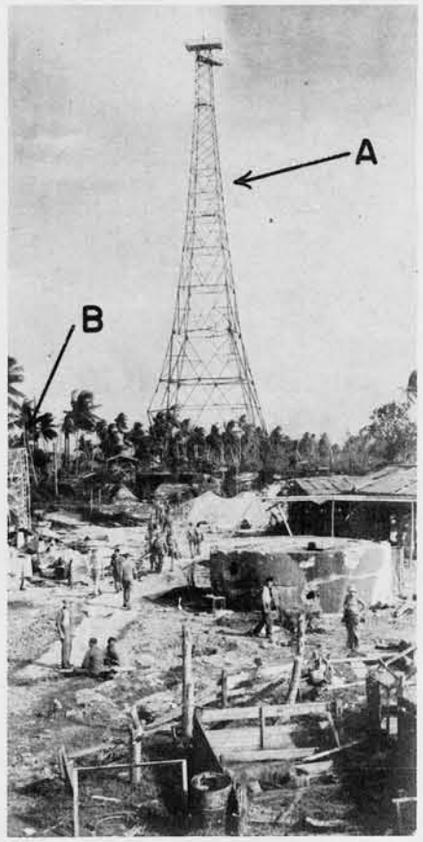
Two lattice masts, 210 feet high, used by the Japanese at Kwajalein. One was damaged during U. S. occupation of the island. The two lattice masts were spaced 500 feet apart.

KWAJALEIN

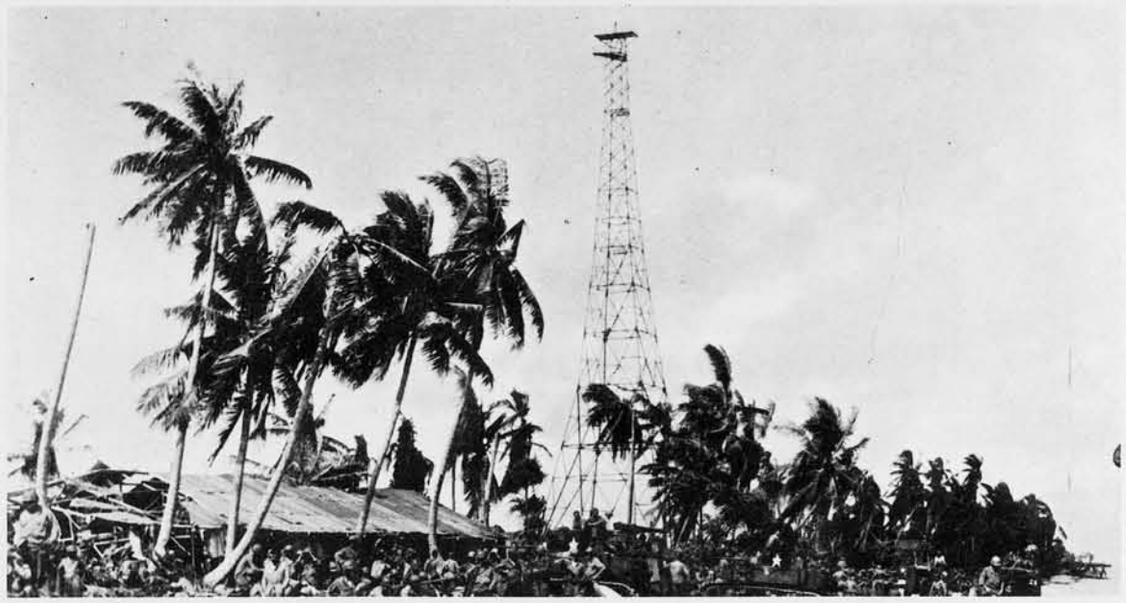
"A" - 210' LATTICE MAST

"B" - SITE OF 210' LATTICE MAST DAMAGED DURING OCCUPATION BY U. S. FORCES.

CAVITE, PHILIPPINES



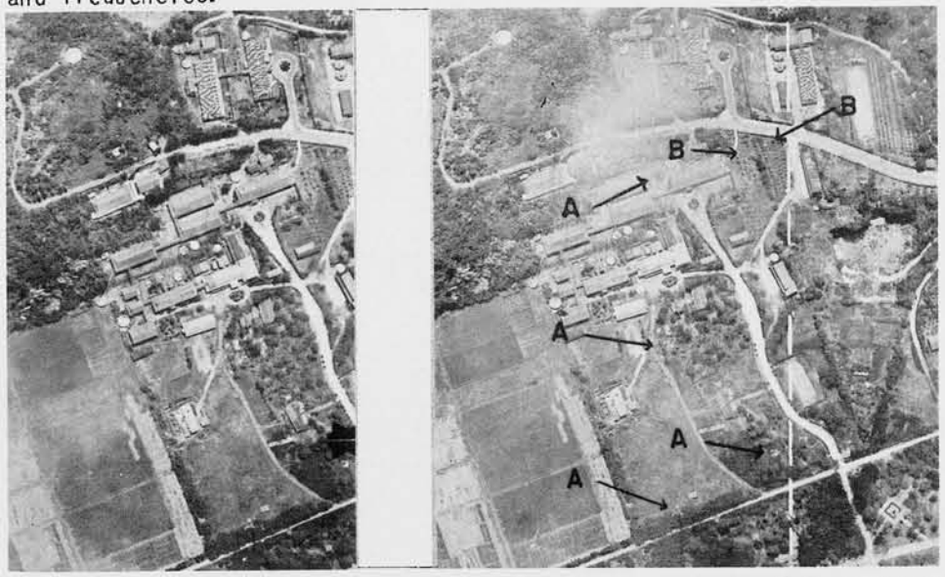
KWAJALEIN



KWAJALEIN

COMMUNICATIONS
COMBINATIONS

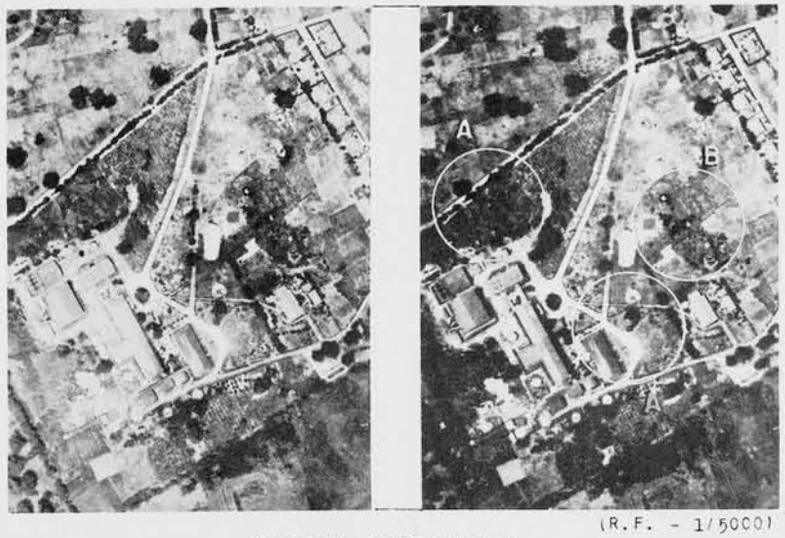
The following two pages of "combinations" are included to make comparisons between the appearance of masts of different types, heights and frequencies.



(R.F. - 1/5000

SAIPAN, MARIANAS

"A" - FOUR 100 LATTICE MASTS. "B" - TWO 50 STICK MASTS.

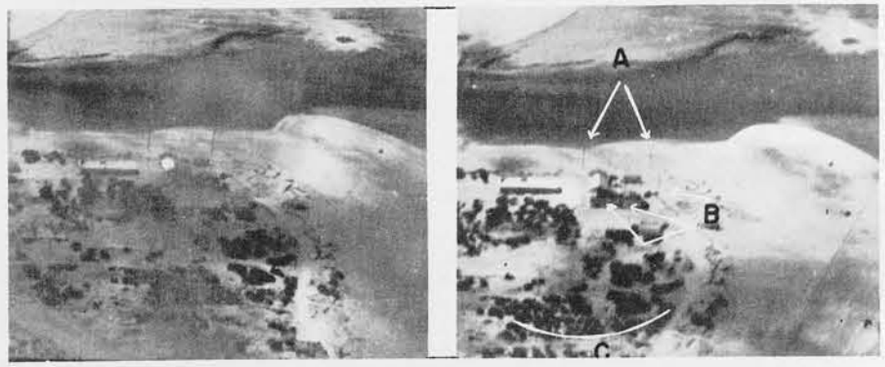


(R.F. - 1/5000)

SAIPAN, MARIANAS

"A" - TWO 125' LATTICE MASTS. "B" - THREE 60' STICK MASTS

When topography is very rough, or when the sun is high at the time of photography, it is difficult to estimate the height of masts.
The two stations above at Saipan probably include Low, Medium, and High Frequency transmitters.
In the lower picture, the three closely spaced stick masts in line are unusual. No report has been received on this from the field, however.



WAKE

(R.F. - 1/2200)

WAKE

"A" - TWO 60' STICK MASTS
"B" - THREE 35' STICK MASTS
"C" - RECEIVING ANTENNAE AND/OR POWER LINES

The above views, when compared, show the value of obliques for picking up detail sometimes missed in vertical coverage. This is a poor example of the capabilities of this method.
Low altitude stereo-obliques, simultaneously exposed, would have great value in electronics interpretation.

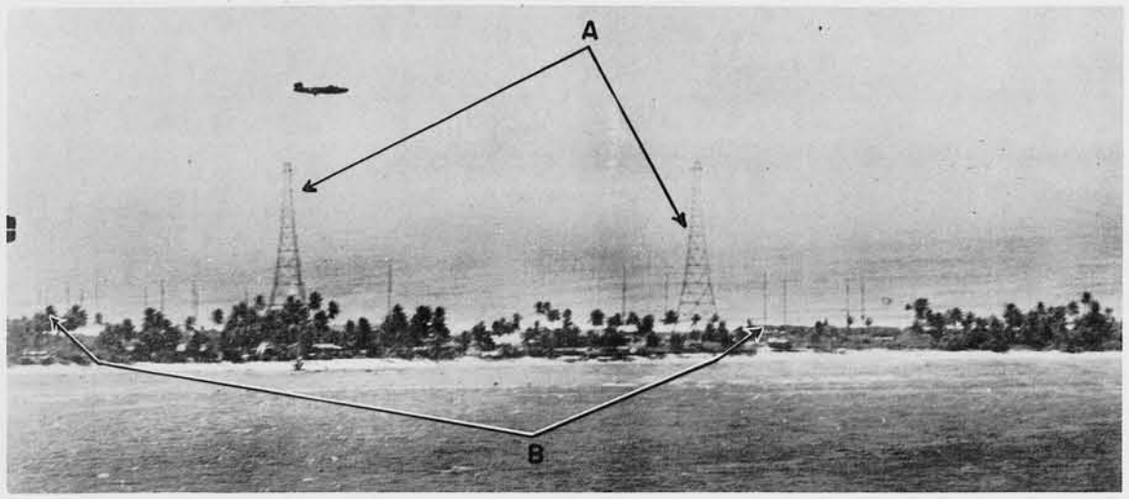
(R.F - 1/14800

TAIHOKU, FORMOSA

"A" - THREE 200' LATTICE MASTS.

"B" - TWO 75'-100' STEEL STICK MASTS.

"C" - TRANSMITTER PROBABLY IN THIS BUILDING.



KWAJALEIN

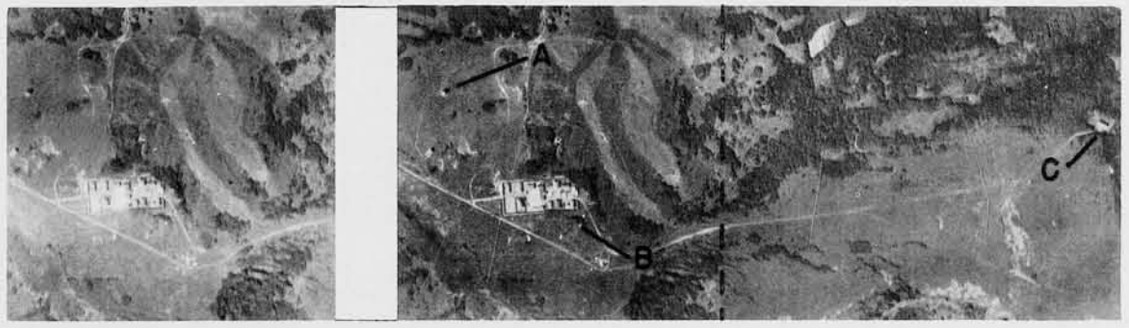
"A" - TWO 210' LATTICE MASTS. "B" - SIXTEEN 60'-75' SPLICED WOOD STICK MASTS.

This station is now in Allied possession. One lattice mast was damaged during occupation.

(R.F. - 1/7500)

OKINAWA

Combined Low Frequency radio communications and weather station at Naha, Okinawa.

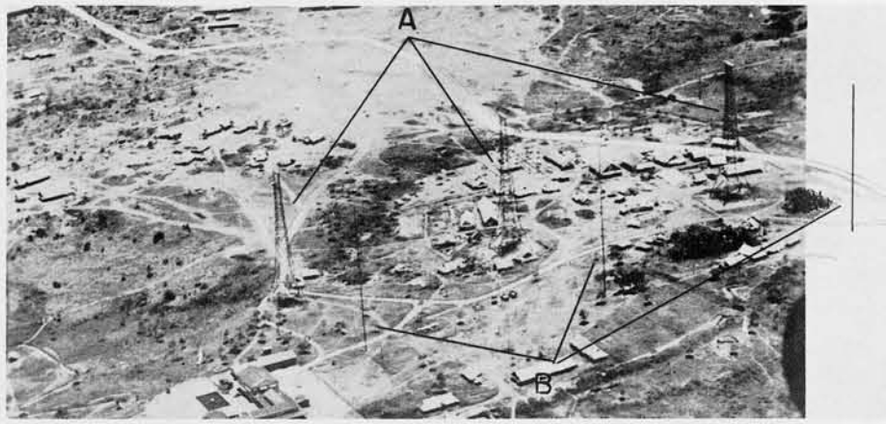


(R.F. - 1/2000)

GARANBI POINT, FORMOSA

"A" - HIGH FREQUENCY D.F. TOWER. "B" and "C" - MEDIUM FREQUENCY COMMUNICATION STATION

Two Medium Frequency Communications Stations in Formosa, spaced 1200 yards apart. One serves as a reporting station for a D.F. aid to navigation.

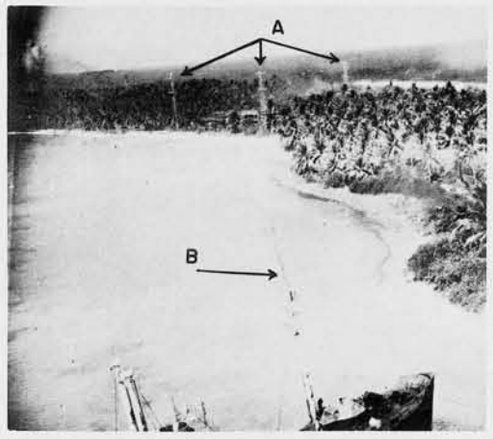


BABELTHUAP, PALAU

"A" - THREE 200' LATTICE MASTS "B" - THREE 150' STEEL STICK MASTS

This is a section of a very large multi-channel Communications Center shown elsewhere in this section. This pattern appears to be directional.

BABELTHUAP, PALAU



JALUIT, MARSHALLS

"A" - THREE 75' LATTICE MASTS "B" - SHIP'S COMMUNICATION ANTENNAE

In the background, can be seen a typical Japanese Military Communications Center with standard concrete building.

COMMUNICATIONS

COMMUNICATION CENTERS

The Japanese have standardized a type of Medium Frequency Communication Center design to such an extent that it is easily recognized, even with very small scale photography. This particular design has been found in about fifteen different localities to date.

The arrangement consists of three 60'-75' Lattice Masts laid out in an equilateral triangular pattern with the communications building in the center of the pattern.

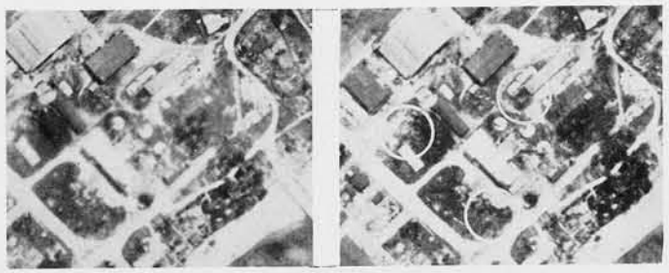
The Communications Building is of modern looking concrete design with flat roof slabs and parapets. It is usually two stories in height and embodies an asymmetrical disposition of roof terraces.

This building houses the transmitter, generators, and storage batteries. In addition are communication offices, living quarters and storage.

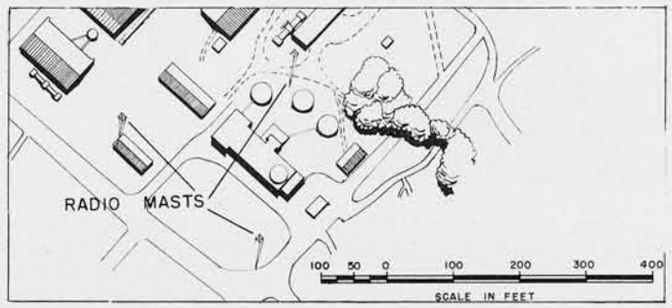
Throughout the Pacific Islands, 20' diameter cisterns (usually three in number) are clustered near the building. Other smaller auxiliary buildings include water cooling tanks (probably for the water-cooled Diesel engines used for generating power), and a concrete oil storage building.

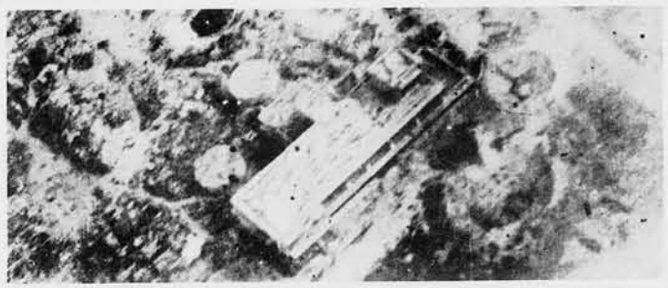
Other types of Communication Centers are also taken up in this section.

All pictures on this page are of a station at Taroa, Maloelap, Marshalls, showing most of the features mentioned. The masts here are spaced 175 feet apart and support the now familiar platforms. These masts are slightly different from the majority used with this type of station in that they are but 60 feet high. The platforms are triangular in shape.

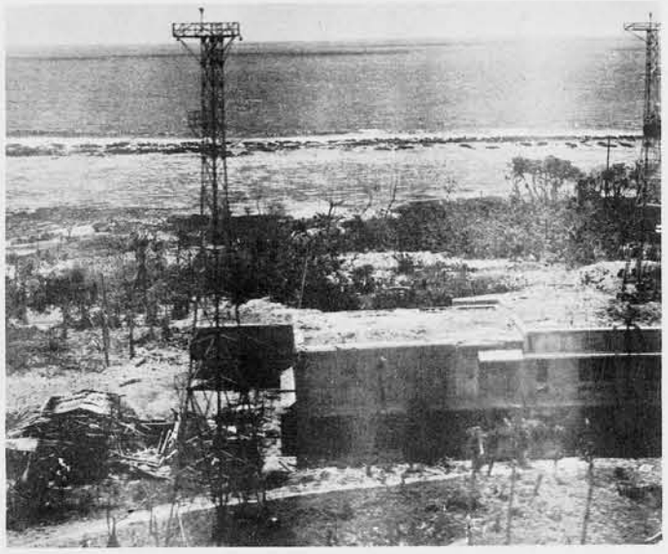


TAROA, MALOELAP (R.F. - 1/5500)





MALOELAP

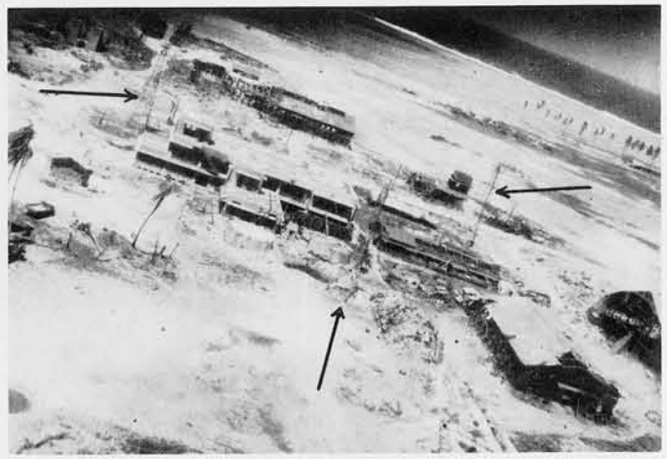


MALOELAP

MALOELAP

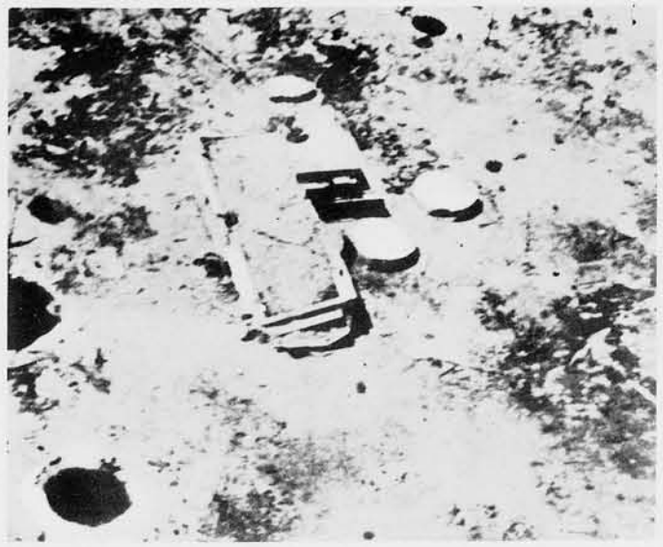
MALOELAP

MALOELAP



MALOELAP

NORTH RADIO STATION, WOTJE

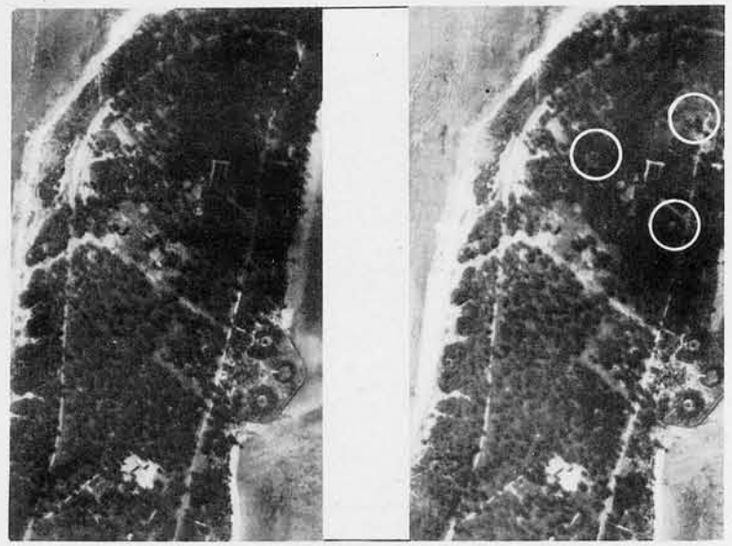


SOUTH RADIO STATION, WOTJE

These stations include the main building, (housing the transmitter, generator, offices etc.), oil storage, water cisterns and cooling tanks.

Although the concrete main buildings vary somewhat in design details, they are sufficiently alike in general form to encourage use of the words "standard type".

The cisterns are not likely to be present when this building is used in areas of adequate fresh water resources. In certain photos, the pipes leading from the roof, where water is collected, to the cisterns, are clearly visible.



(R.F. - 1/10000)

WOTJE, GILBERTS

SOUTH RADIO STATION, WOTJE

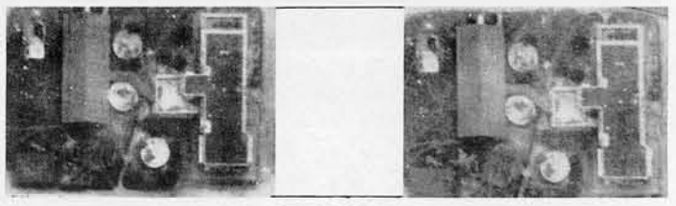
WOTJE, GILBERTS

WOTJE, GILBERTS

Oblique showing three 75 foot lattice masts with platforms and concrete building of typical design.

"A" - THREE LATTICE MASTS TYPE L-5

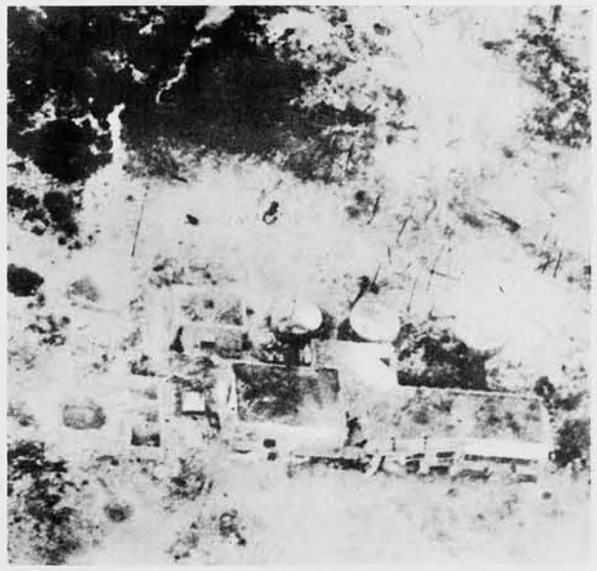
"B" - VISUAL SIGNALLING LIGHT



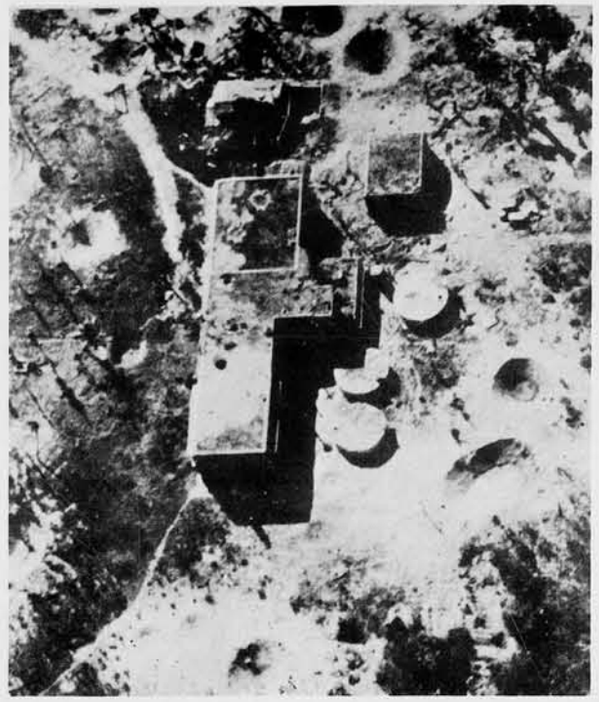
TINIAN (R.F. - 1/2500)

Detail of Center at Tinian reveals building very similar to that at Taroa, Maloelap.

COMMUNICATIONS
COMMUNICATION CENTERS (CONT.)

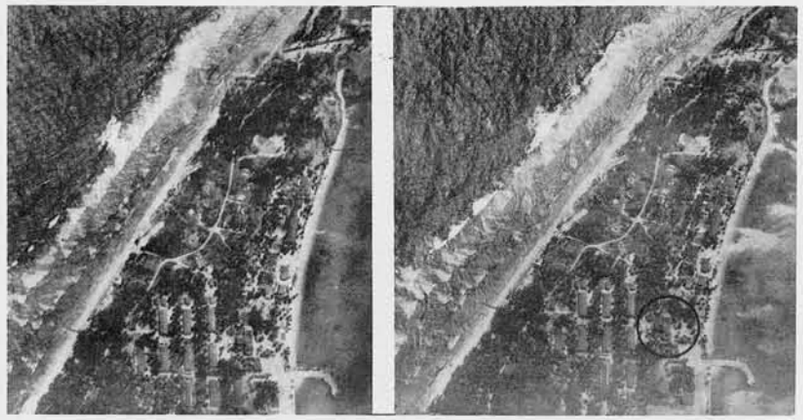


JALUIT, MARSHALLS



PIGEEYATTO, MALOELAP, MARSHALLS

Standard building, water cooling tanks, oil storage building, and cisterns are all present. The cellular construction in the water-cooling tank building is visible in the partly destroyed example above.

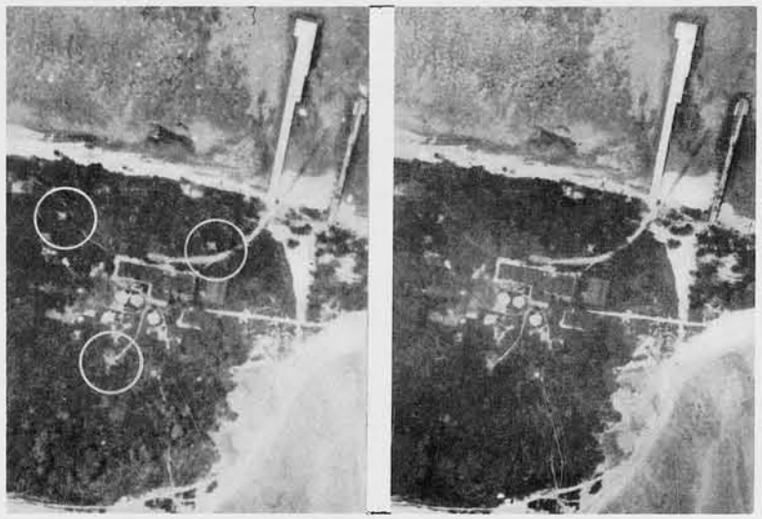


(R.F. - 1/11000)

JALUIT

In these pictures of Jaluit Communications Center, in which the location of masts is very difficult to determine, the standardized type of concrete building serves well for identification purposes.

All of these concrete buildings contain fairly powerful transmitters in the Medium Frequency band. The approximate reliable range is 500 miles, but they may transmit a great deal further, especially at night.

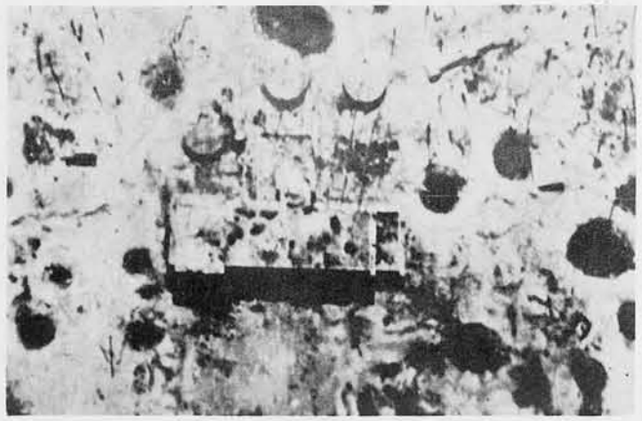


(R.F. - 1/2500)

PIGEEYATTO, MALOELAP

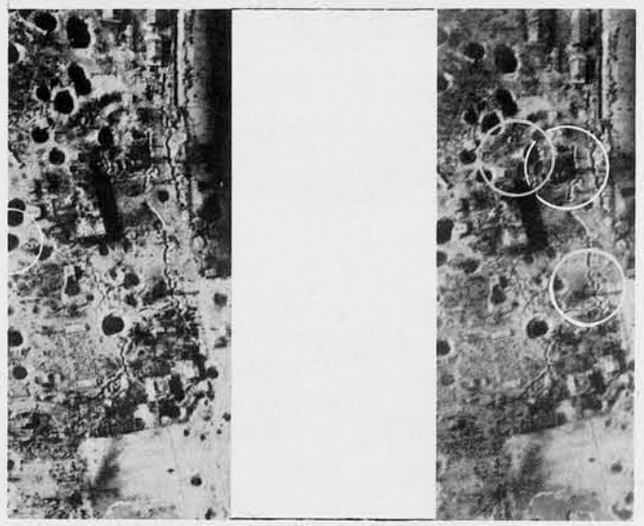
Another Medium Frequency Communications Center at Maloelap. This station is located on Pigeeyatto Island.

Here the masts are of the same type and dimensions as at Taroa, i.e. 60 feet high, 175 foot spacing, and a single triangular platform at the top.



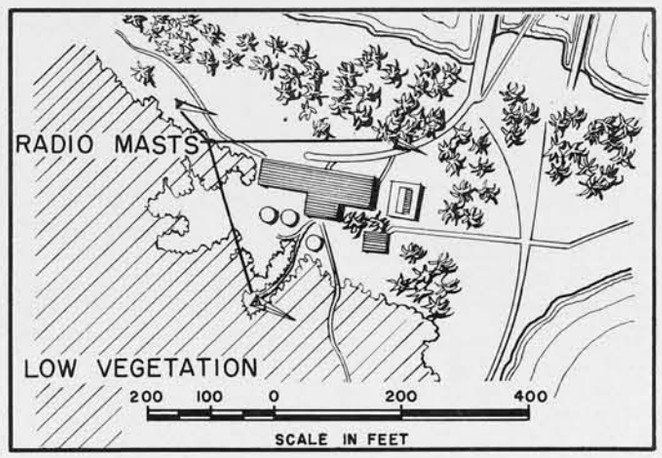
(R.F. - 1/1300±)

JALUIT

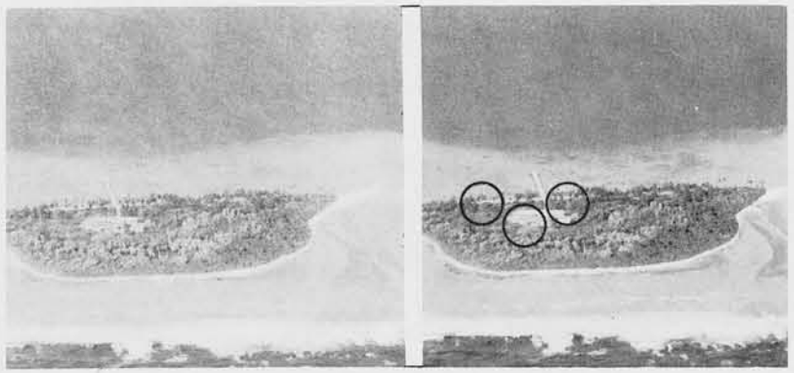


(R.F. - 1/4000)

JALUIT



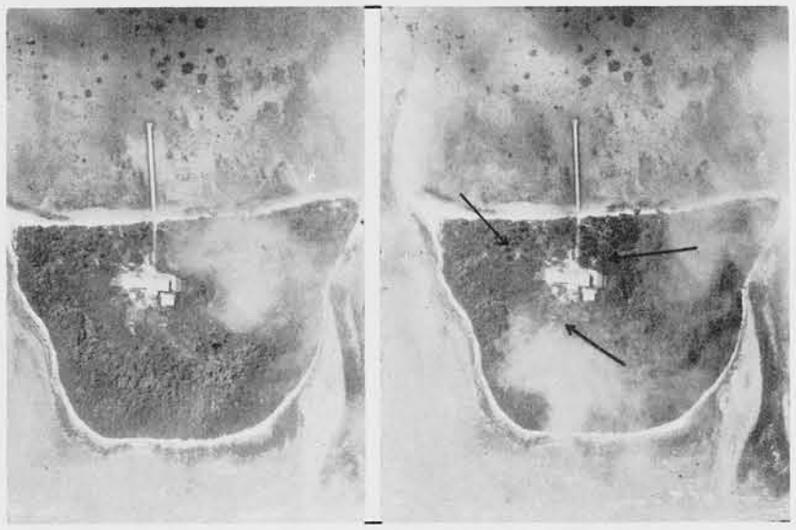
PIGEEYATTO, MALOELAP



ENNUBIRR, KWAJALEIN, MARSHALLS

The pictures and plans on this page are of a Medium Frequency Communications Center on Ennubirr Island, Kwajalein Atoll, Marshall Islands.

Apparently, the sole military use of this particular island was radio communication, and the "Standard" buildings and arrangement were employed.

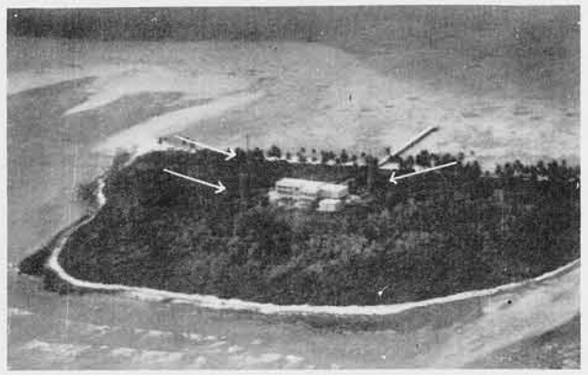


(R.F. - 1/10000)

ENNUBIRR

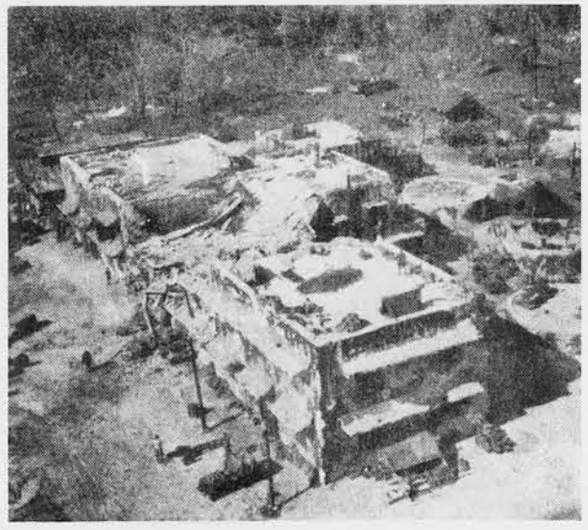
This installation has three lattice towers, 75 feet high, which are spaced 350 feet apart. This indicates that it is a fairly powerful station in the Medium Frequency band (.3 to 3 mcs.) and probably has a reliable range of 500 to 800 miles when operating under normal conditions.

The Ennubirr Station is one of several communication stations at Kwajalein, which are mostly High and Medium Frequency, with one probable Low Frequency.



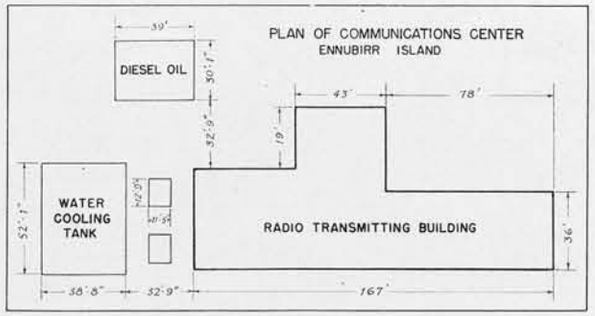
ENNUBIRR

The buildings are as follows: main concrete communications building, concrete oil storage building and three 20 foot diameter concrete cisterns. A long pier for transportation and supplies was necessary because of the shallow water over the coral reefs. This is evidently the only means of access to the island.



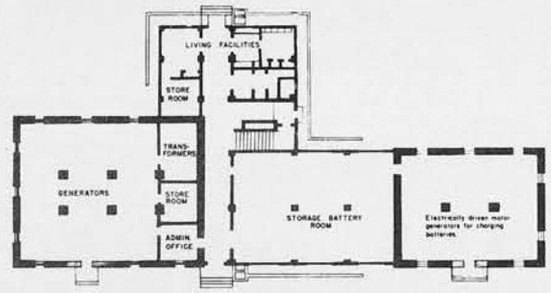
ENNUBIRR

From these examples it can be more forcibly realized the extent to which the Japanese have developed a Military Communication network throughout their empire. Ample and reliable communication facilities, throughout widely dispersed areas and involving great expanses of water, are an imperative need of the Japanese military machine hence their great reliance on radio.

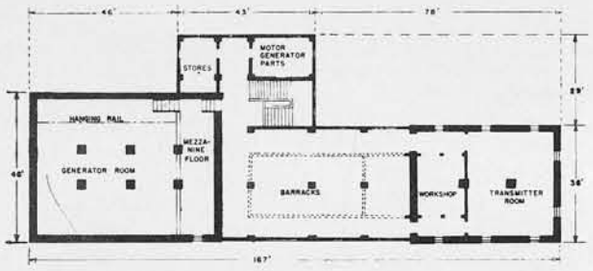


PLOT PLAN OF ENNUBIRR

The two small rectangles between the transmitting building and the water cooling building may represent exhausts for the Diesel engines. Water cooling tank buildings are built of wood with pitched roof and monitor. Oil storage buildings are usually concrete with flat roofs.



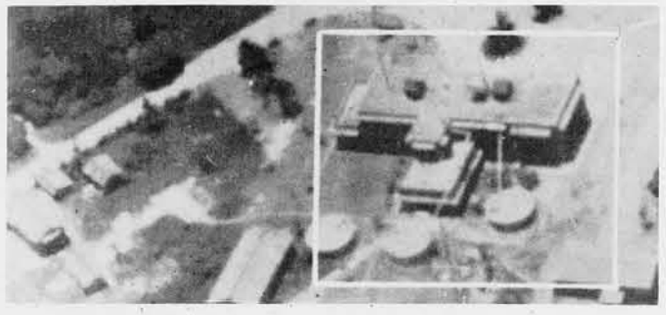
FIRST FLOOR PLAN



SECOND FLOOR PLAN

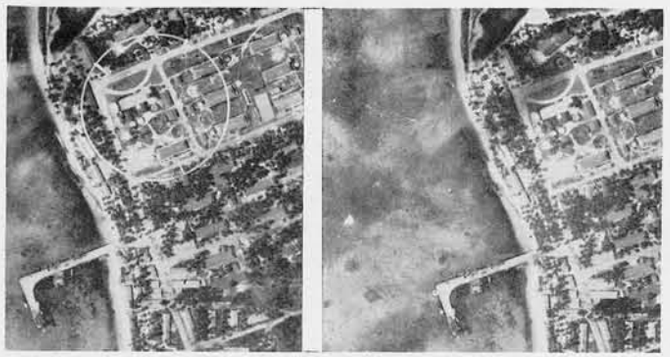
The first floor contains most of the services, engines and heavy equipment. The structure is heavy and well-built of reinforced concrete. The second floor contains most of the electrical equipment (such as the transmitter, which is most vulnerable and difficult to replace), and also barracks for the crew. The generator room ceiling is two stories in height.

COMMUNICATIONS
COMMUNICATION CENTERS (CONT.)



PALAU

This station at Pelelieu Island, Palau, is apparently the 75 foot mast, Medium Frequency standard type. However, there appear to be two additional 30 foot masts erected on top of the building. These latter masts probably carry antennae for High Frequency Communication. The absence of the water cooling and oil storage buildings suggests that power may be fed to this point from a remote station.

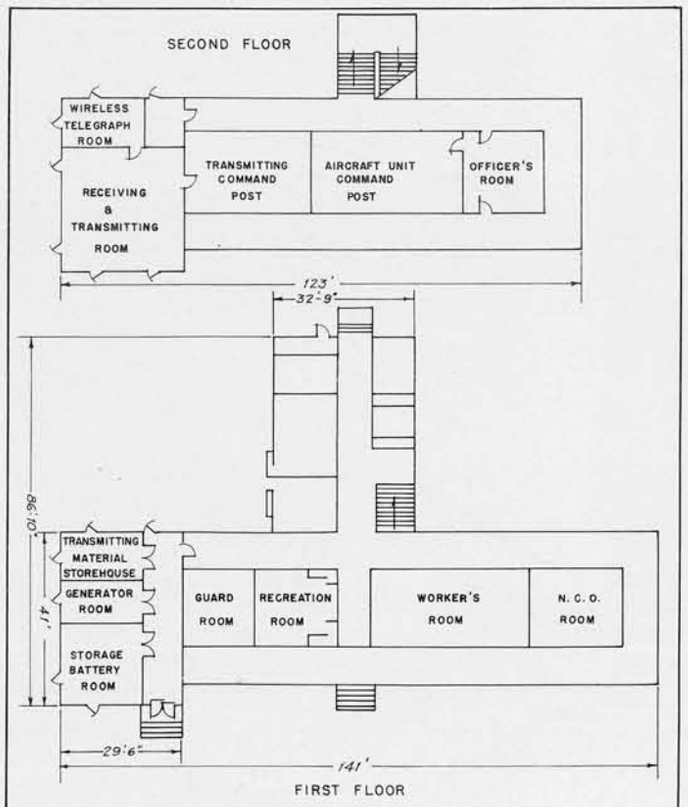


(R.F. - 1/10000)

NAMUR, KWAJALEIN

This building is probably used as a command headquarters in addition to a message center.

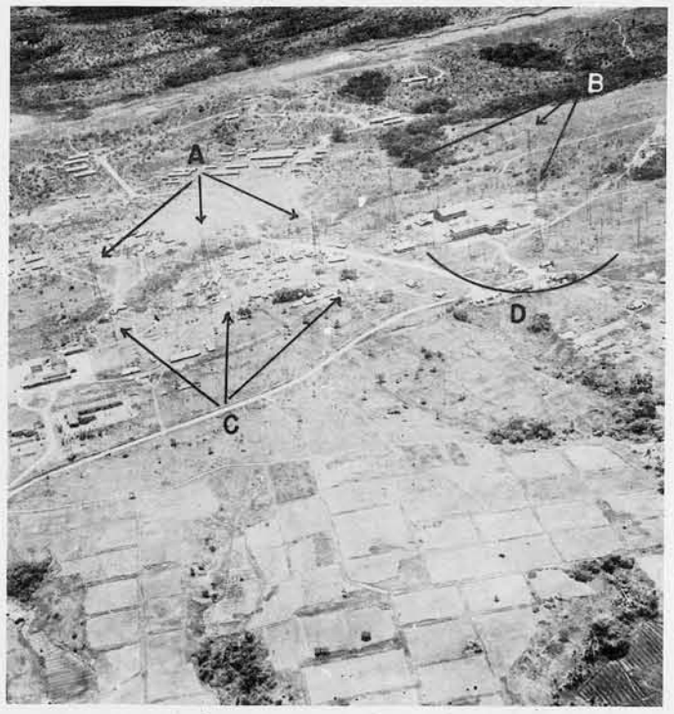
The "Headquarters Building" on Namur Island, Kwajalein, is mainly a Communications Center, serving also as a command post, (which is true of many examples of this standardized type concrete building). This station transmits at Medium Frequency.



HEADQUARTERS BUILDING
NAMUR ISLAND

PALAU

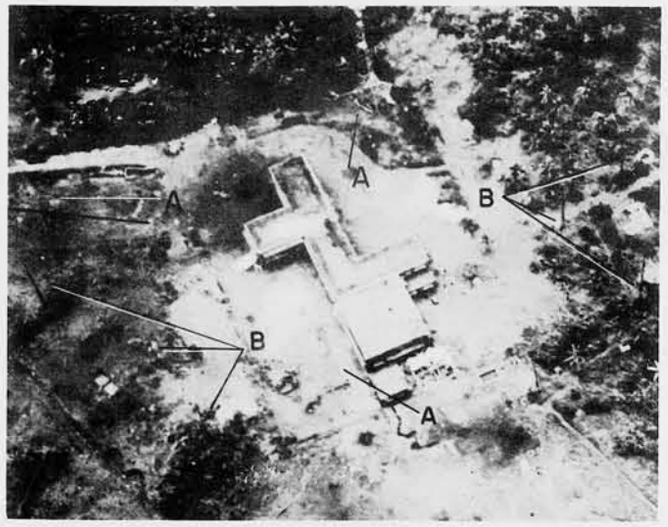
One of the largest Japanese Communication Centers seen to date is this one on Babelthuap Island, Palau. Such a station may operate on many frequencies, ranging from High to Low. It may be best described as a Multi-channel Communication Center.



PALAU

"A" - THREE 200' LATTICE MASTS (QUADRUPED)
"B" - THREE 250' LATTICE MASTS (TRIPOD)
"C" - THREE 150' ± STEEL STICK MASTS
"D" - SEVENTEEN (VISIBLE) WOOD STICK MASTS 50'-75' IN HEIGHT AND ONE STEEL STICK MAST, 150' HIGH.

Small poles are power poles. All other masts visible probably support transmitting antennae.



TRUK

This station, because of its more elaborate mast system and the larger, more complex form of the communications building, appears to be of a multi-channel type, operating on Low, Medium, and possibly High Frequencies.

"A" - THREE 125' LATTICE MASTS
"B" - SIX 50' - 60' SPLICED WOOD STICK MASTS

CONCRETE - 25' x 35'

ABOVE: Two examples of bomb proof communications and command posts. These are quite small as compared with the concrete Communications Center Buildings. The design of heavy reinforced concrete

CONCRETE - 14' x 60'

varies considerably. The transmitters in these posts are probably high and medium frequency and are used in connection with ground troops and A. A. and C. D. batteries.

GUAM

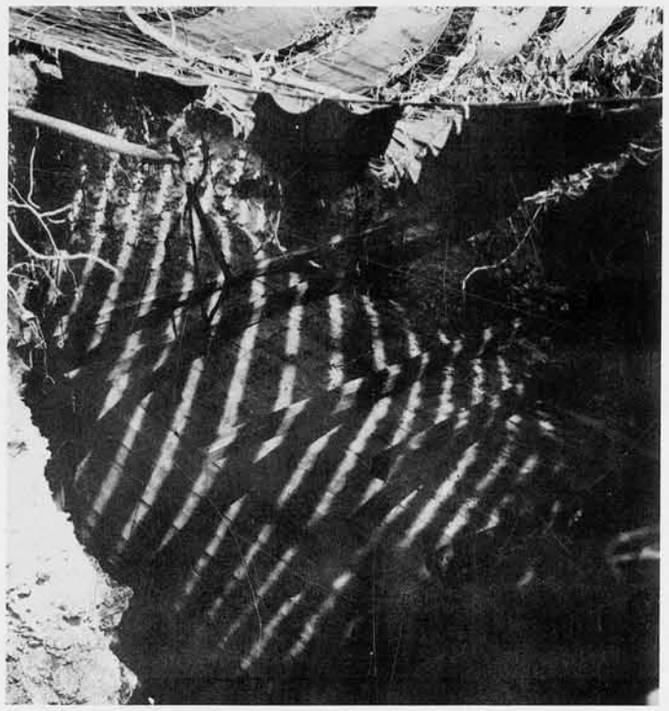
Interior view of concrete vault shown at bottom of page. Inside dimensions are 13' x 45'.

GUAM

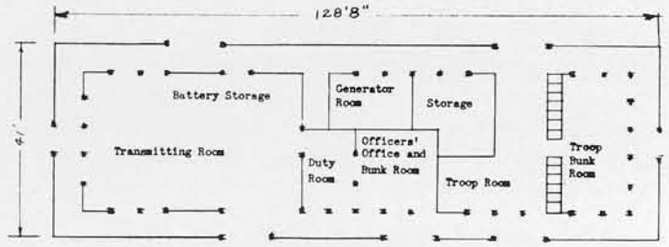
Transmitter in small buried communications center. Observation of tracks and presence of antenna masts are clues to this type of station.

ENTRANCE

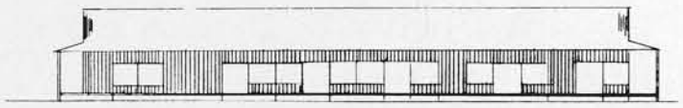
Entrance to completed vault is shown here. Eight feet of coral backfill has been placed on top of vault which is 18 feet wide by 50 feet long (outside dimensions). Concrete is 2½ feet thick.



Exterior view of buried concrete barrel vault Communications Center at Guam, designed mainly for local ground force communication while under attack. These types are extremely hard to locate on aerial photos and are strongly resistant to bomb damage. Note camouflage during construction.



PLAN

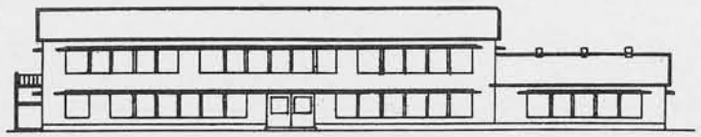


ELEVATION

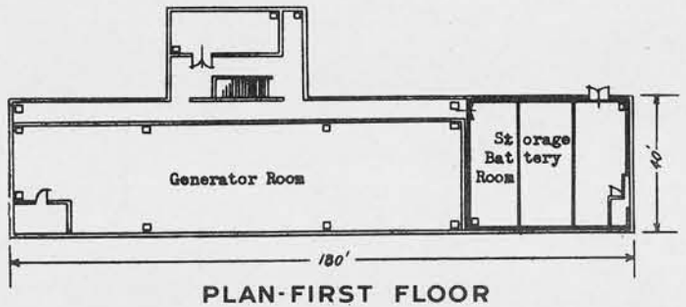
The standard Japanese prefabricated barracks building is used as a communications center in several instances. When radio masts are visible near barracks buildings, there is a good chance that the barracks nearest to them contains the transmitter. Transmitting rooms are invariably at the end of a building, and on the second floor, if a two story structure.

COMMUNICATIONS

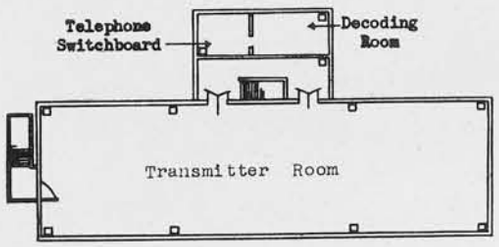
COMMUNICATION CENTERS (CONT.)



FRONT VIEW



PLAN-FIRST FLOOR



PLAN-SECOND FLOOR

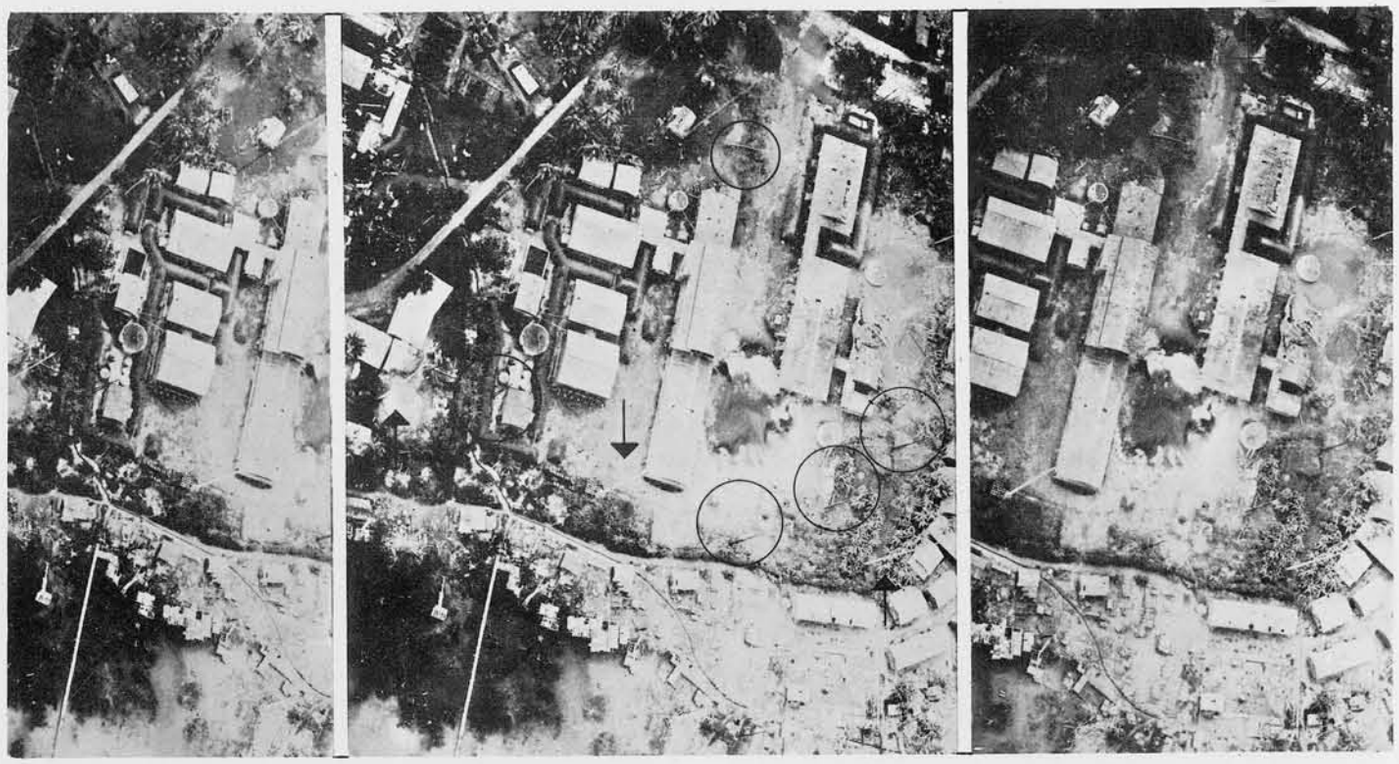
Another type of communications center which is apparently a development of the prefabricated barracks building. This structure is two-storied, with the transmitter on the second floor.

The design of Communication Center, at the southwest tip of Dublon Island, is curiously jumbled and makeshift for a station that is apparently quite powerful.

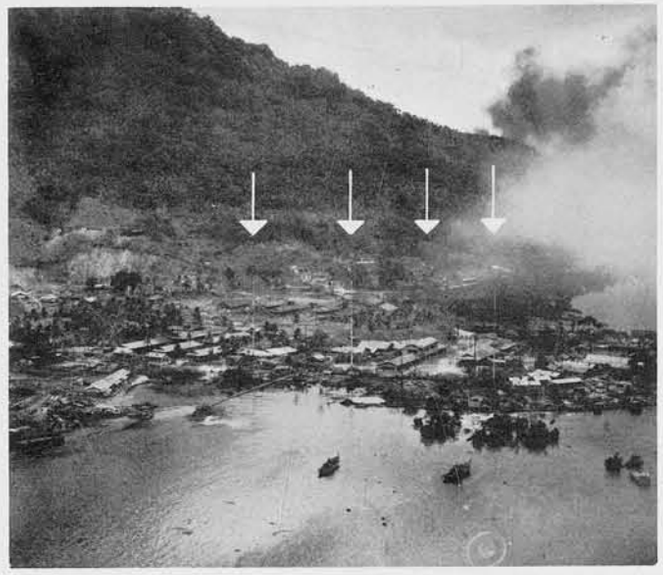
High and Medium Frequency transmitters are likely to be present, the latter with fairly good range. The tallest stick masts are 100 feet high; the spliced wood stick masts are about 60 feet.

FAR RIGHT: This Center, on the north side of Dublon town, utilizes three typical 125 foot lattice masts with platforms and an informal arrangement of stick and spliced wood stick masts. There is very likely a low frequency transmitter present in connection with the lattice masts.

All of the pictures on this page are examples of the use of prefabricated barracks-type buildings in connection with Communication Centers. Most are one story in height and are 38 feet wide, including roof overhang.

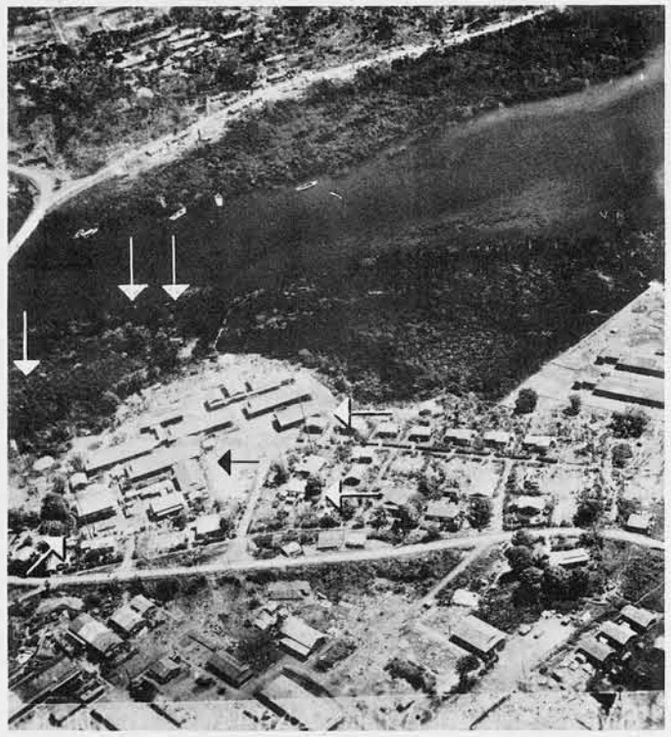


S. W. DUBLON, TRUK



S. W. DUBLON, TRUK

This communication center at Truk is a multichannel station operating at various frequencies including long range, medium or low frequency. The informal, jumbled nature of the group is not very typical of the larger stations.



DUBLON TOWN, TRUK

COMMUNICATIONS
WEATHER STATIONS

Japanese military Weather Stations are fairly easily recognized in small scale photography by the following features:

1. 50'-60' steel (sometimes wood) tower containing wind instruments for recording speed and direction and/or low wooden platform constructed on top of roof of main building.

2. Three small white-painted instrument houses, usually in line. These are roughly 3' to 5' square - but show up very plainly because of their pure white color.

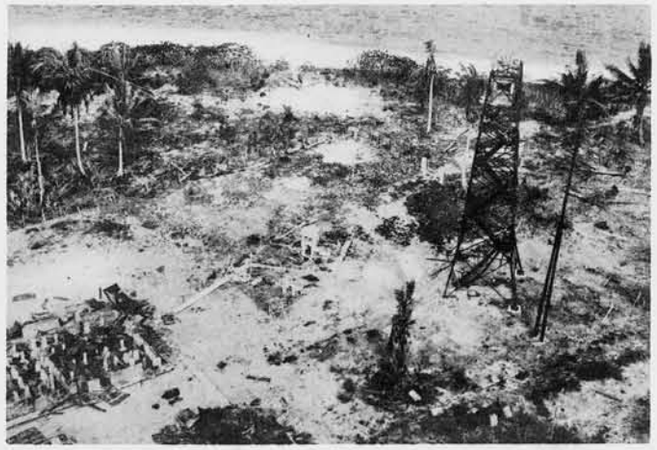
3. If near water, may have tide guage house.

4. Main building for transmitting, offices, quarters, etc.

5. Other buildings present are likely to be barracks, generator building, oil storage and water storage.

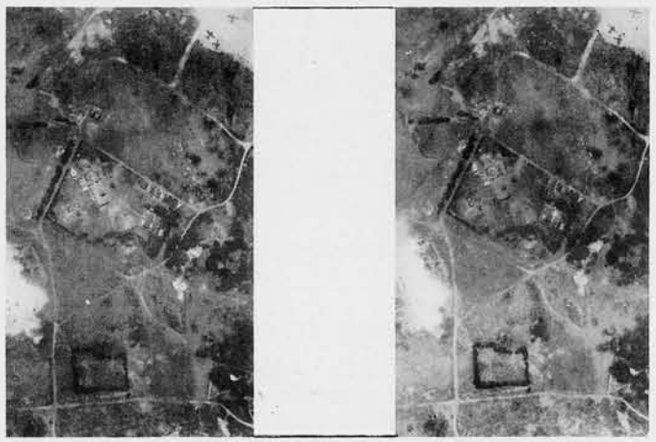
6. Two spliced wood stick masts supporting antennae for reporting station.

BELOW: This weather station at Yap is unusual in that four stick masts are used for communications. In most stations, only the two spliced masts are present.



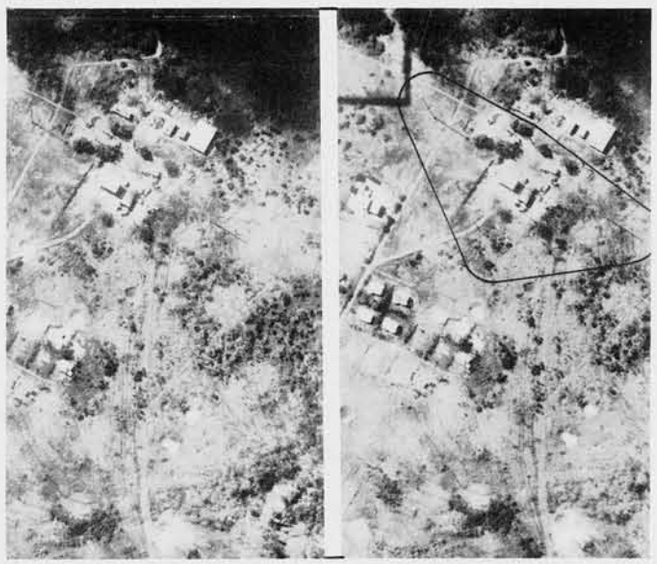
NAMONUITO, CAROLINES

NAMONUITO, CAROLINES

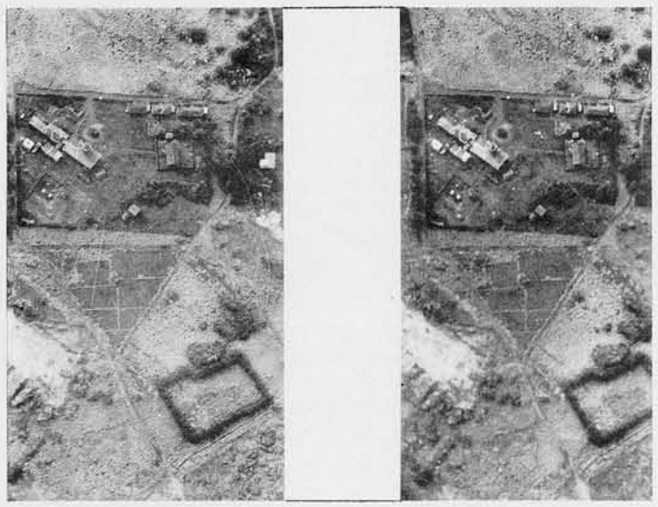


IWO JIMA, KAZAN (R.F. - 1/9100)

MAUG, MARIANAS (R.F. - 1/4000)



YAP (R.F. - 1/5000)



IWO JIMA, KAZAN (R.F. - 1/5000)

MAUG, MARIANAS

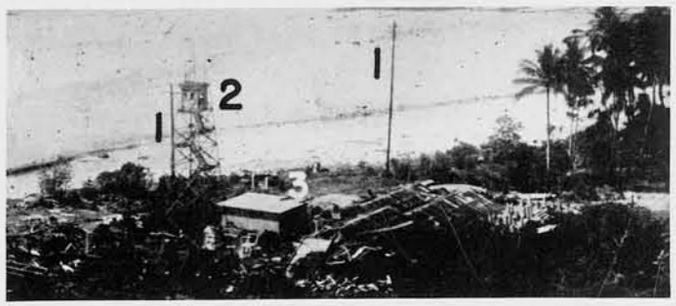
COMMUNICATIONS
WEATHER STATIONS (CONT.)

KAVIENG, NEW IRELAND

"A" - SPLICED WOOD STICK MASTS
"B" - PROBABLE GENERATOR BUILDING
"C" - WEATHER INSTRUMENT HOUSES

UJAE, MARSHALLS

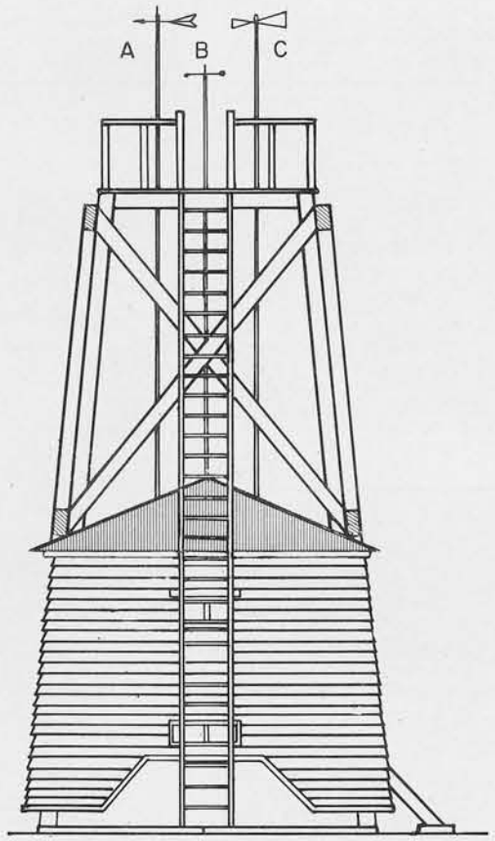
"A" - STICK MAST
"B" - PROBABLE GENERATOR BUILDING
"C" - TOWER FOR WIND RECORDING INSTRUMENTS
"D" - WEATHER INSTRUMENT HOUSES
"E" - TIDE GAUGE HOUSE



KAPINGAMARANGI, CAROLINES

"1" - TWO 75 FEET HIGH STICK MASTS WITH CROSS PIECES AT TOP.
"2" - WEATHER STATION TOWER.
"3" - PROBABLE GENERATOR BUILDING.

A tide gauge house is probably present.

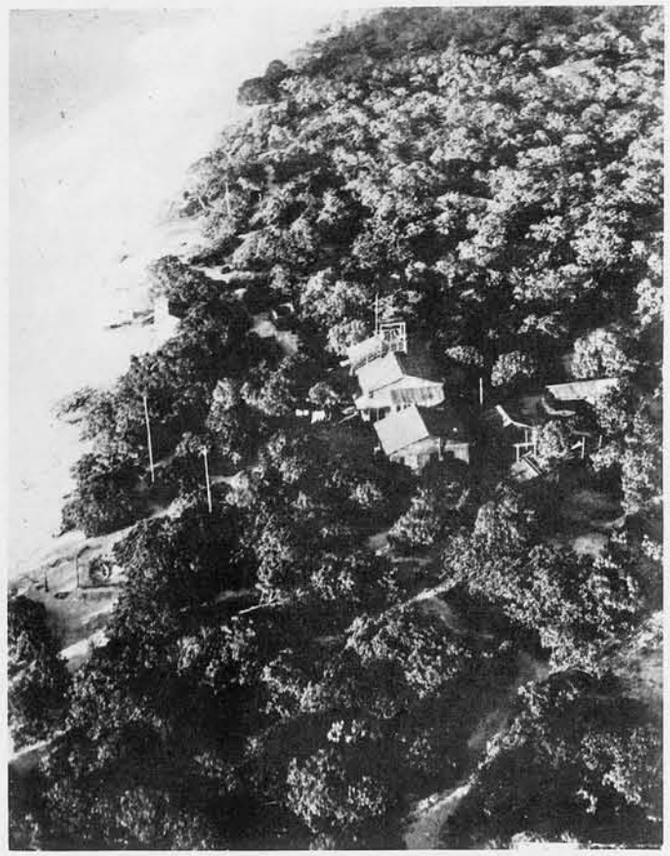


ELEVATION

Drawing of a Japanese Weather Station tower showing instruments common to this installation.

"A" - WEATHER VANE.
"B" - ANEMOMETER.
"C" - VENTURI TUBE FOR RECORDING WIND VELOCITY.

NGULU, CAROLINES

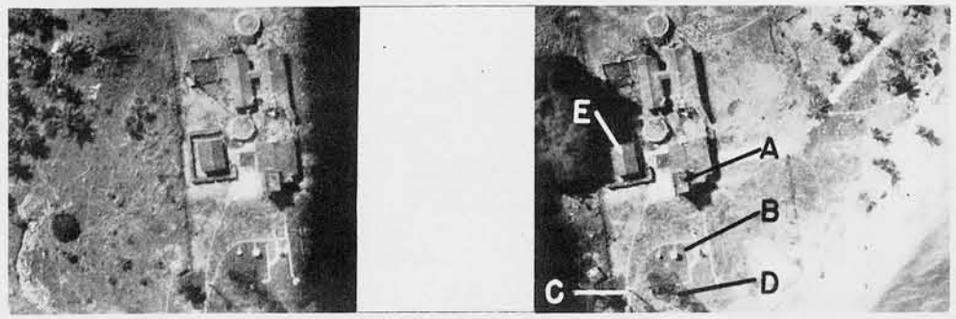


TAONGI, MARSHALLS

This weather station at Taongi is identified by the tower platform atop the main building and by the presence of radio masts.

A tide gauge house is probably present.

NGULU, CAROLINES



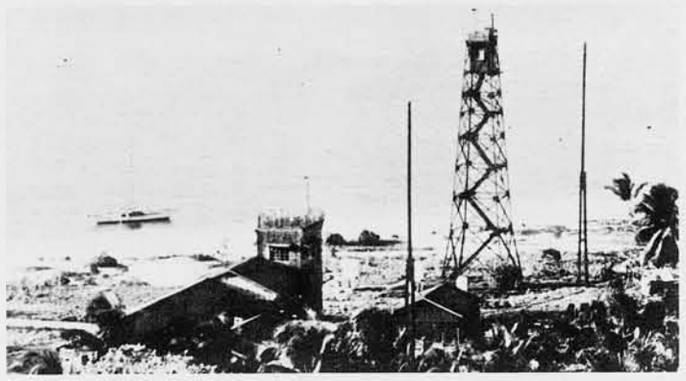
(R.F. - 1/2000)

RONGELAP, MARSHALLS

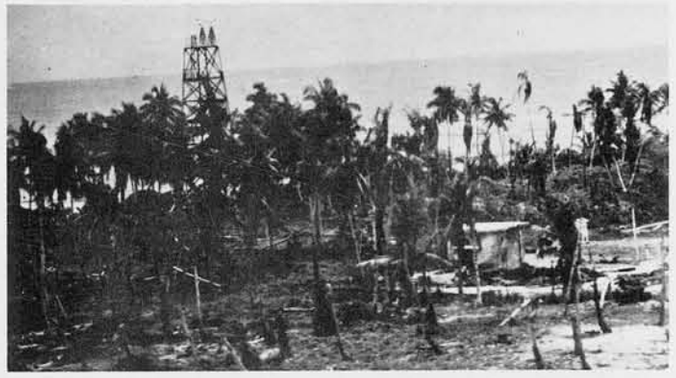
"A" - TOWER PLATFORM
"B" - WEATHER INSTRUMENT HOUSES
"C" - STICK MAST FOR RADIO
"D" - STEEL TOWER
"E" - PROBABLE GENERATOR BUILDING

"A" and "D" are both used for recording wind direction and velocity. Note strong pattern created by weather instrument houses. These houses contain instruments for determining temperature and barometric pressure and include recording barographs. They are always painted white in order to get standard constant readings.

PINGELAP, MARSHALLS



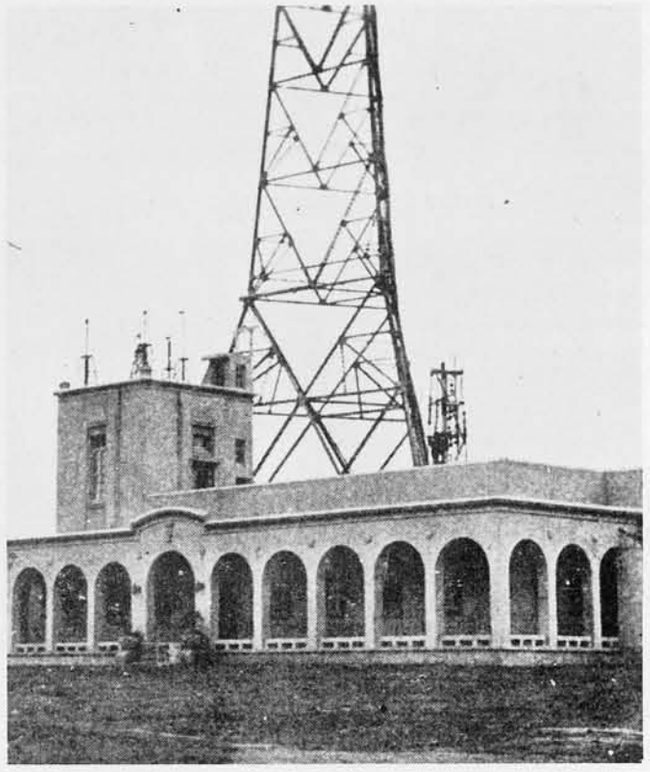
RONGELAP – BEFORE



ULITHI, CAROLINES

RONGELAP – AFTER

ULITHI, CAROLINES



NAHA, OKINAWA

Example of a large pre-war Weather Station

COMMUNICATIONS

GERMAN

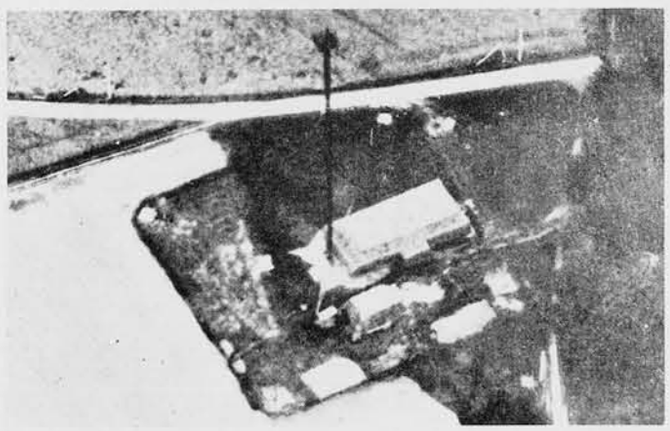
German Radio practice differs in many ways from the Japanese, and examples are shown on these two pages to illustrate this fact.

Most German radio is likely to be in the High or Very High Frequency bands, although Medium Frequency is used also. Very few Low Frequency stations are found, however.

A collection of tall, (300 feet high) lattice masts is likely to mean a powerful short wave transmitter, rather than Low Frequency as would be the case in Japanese stations.

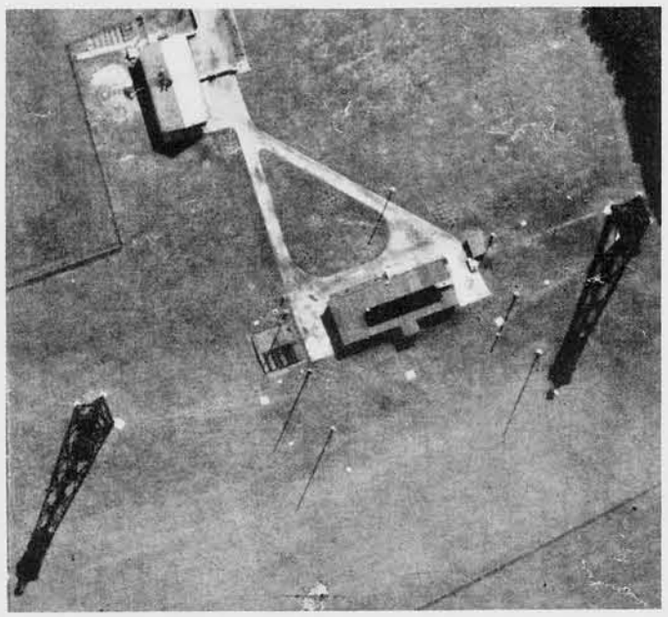
The Germans also employ point to point relay stations at V.H.F. (Decimeter Stations) and High Frequency directional layouts.

DECIMETER STATION

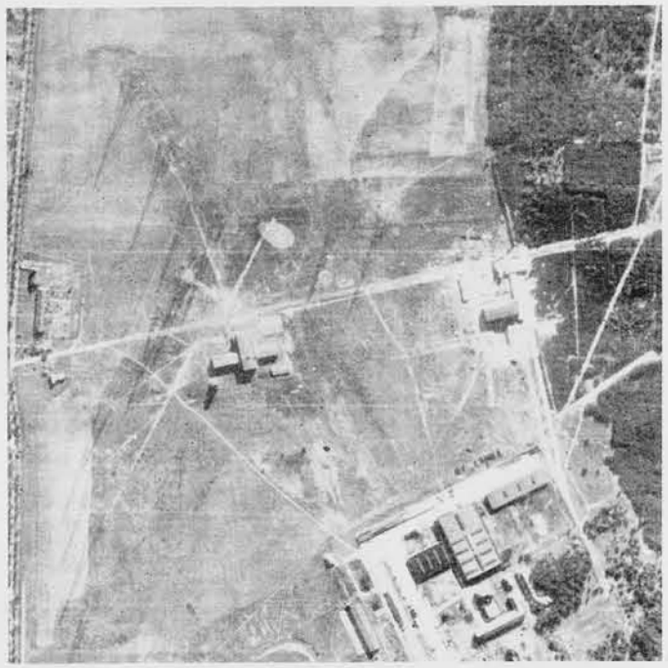


DECIMETER STATION

The above German Decimeter Station is near Le Havre, France. This equipment, widely used for German point to point communications, is Very High Frequency. The stations are spaced 30 miles apart and have masts 160 feet high.

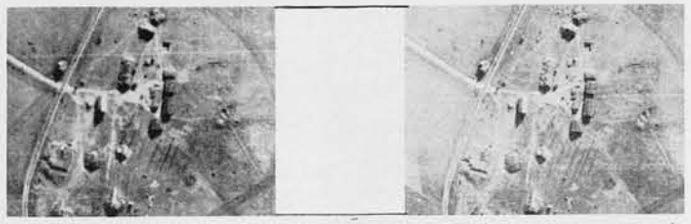


GERMAN



POWERFUL SHORT WAVE

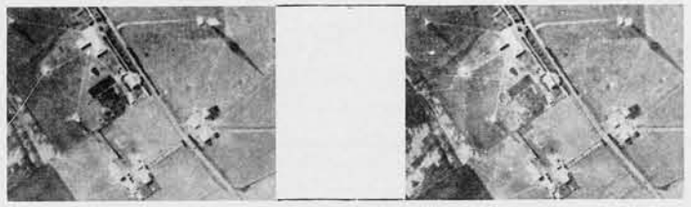
Giant short wave High Frequency transmitter, Zeesen. There are 10 masts 350 feet high. When high lattice masts are used in German radio, it is likely to indicate powerful High Frequency transmission. In Japanese-held territory, however, such masts would be likely to represent Low Frequency.



(R.F. - 1/9000±)

FIELD RADIO

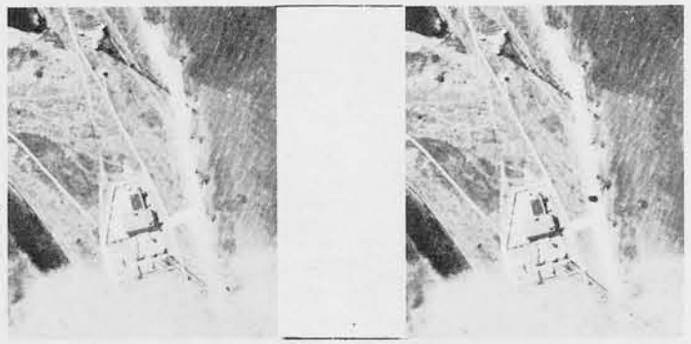
This German field radio station is similar to certain Japanese headquarters stations.



(R.F. - 1/10000±)

BROADCAST STATION

This station is a commercial station. Note German type lattice masts.

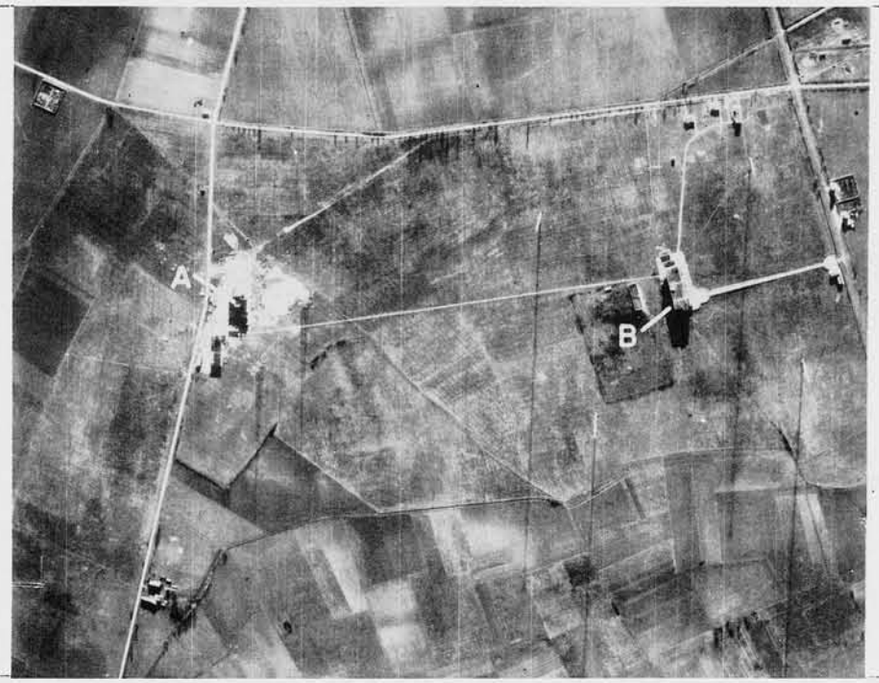


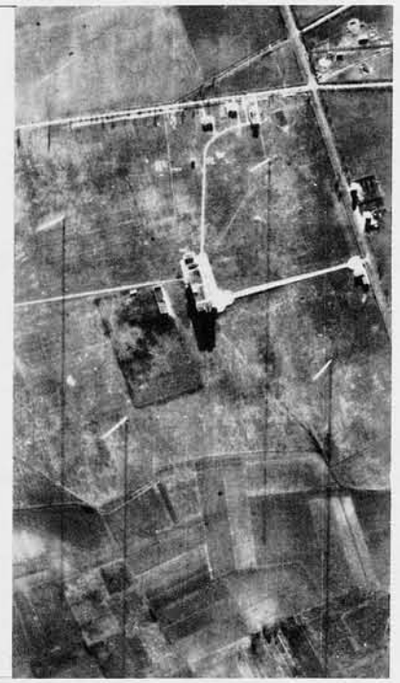
(R.F. - 1/2500 - no parallax)

DENMARK

These masts are approximately 350 feet high, spaced 250 feet apart, and indicate a powerful shortwave transmitter.

WEATHER STATION, SPITZBERGEN





BOURGES, FRANCE

Two very large stations under construction at Bourges.

Station "A" consists of 4 masts 800 feet high, insulated at base and guyed to concrete deadmen. The square pattern is ¼ mile on a side.

Station "B" consists of two lattice masts 350 feet high spaced 480 feet apart. Small stick masts, irregularly spaced, are present also, and may constitute an earth device.

These stations probably will operate on many different frequencies and will have great range. Station "A" is of French radio design; a similar type installation may be seen at Saigon, French Indo China.

VALHERMIEL, FRANCE

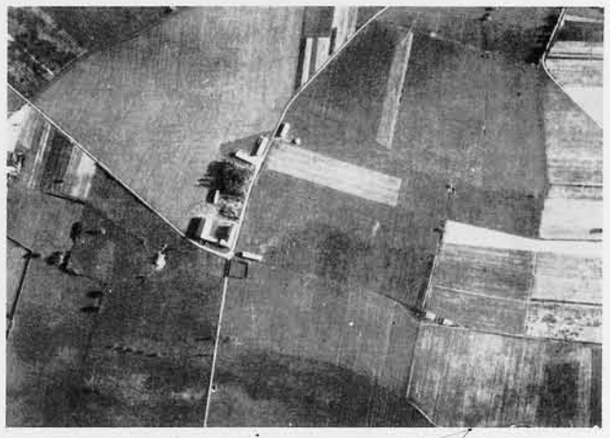
View of German type High Frequency masts with some stick masts of a directional Rhombic layout in the background. This station also has Medium Frequency masts (not shown).

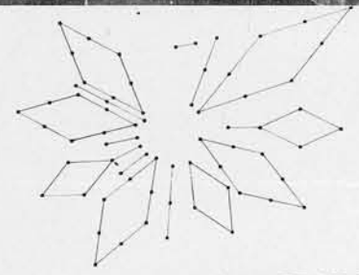
Antennae on High Frequency masts are probably in a vertical position.

(R.F. - 1/10000±)

GERMANY

Probable Medium Frequency Communication Station at an aircraft plant in Germany. The small square building probably contains the transmitter.





ROANNES CHANCEY, FRANCE

Directional Rhombic layout in France. This pattern may be used for highly directional transmitting and receiving of communications. It is a common Radio Intercept pattern.

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

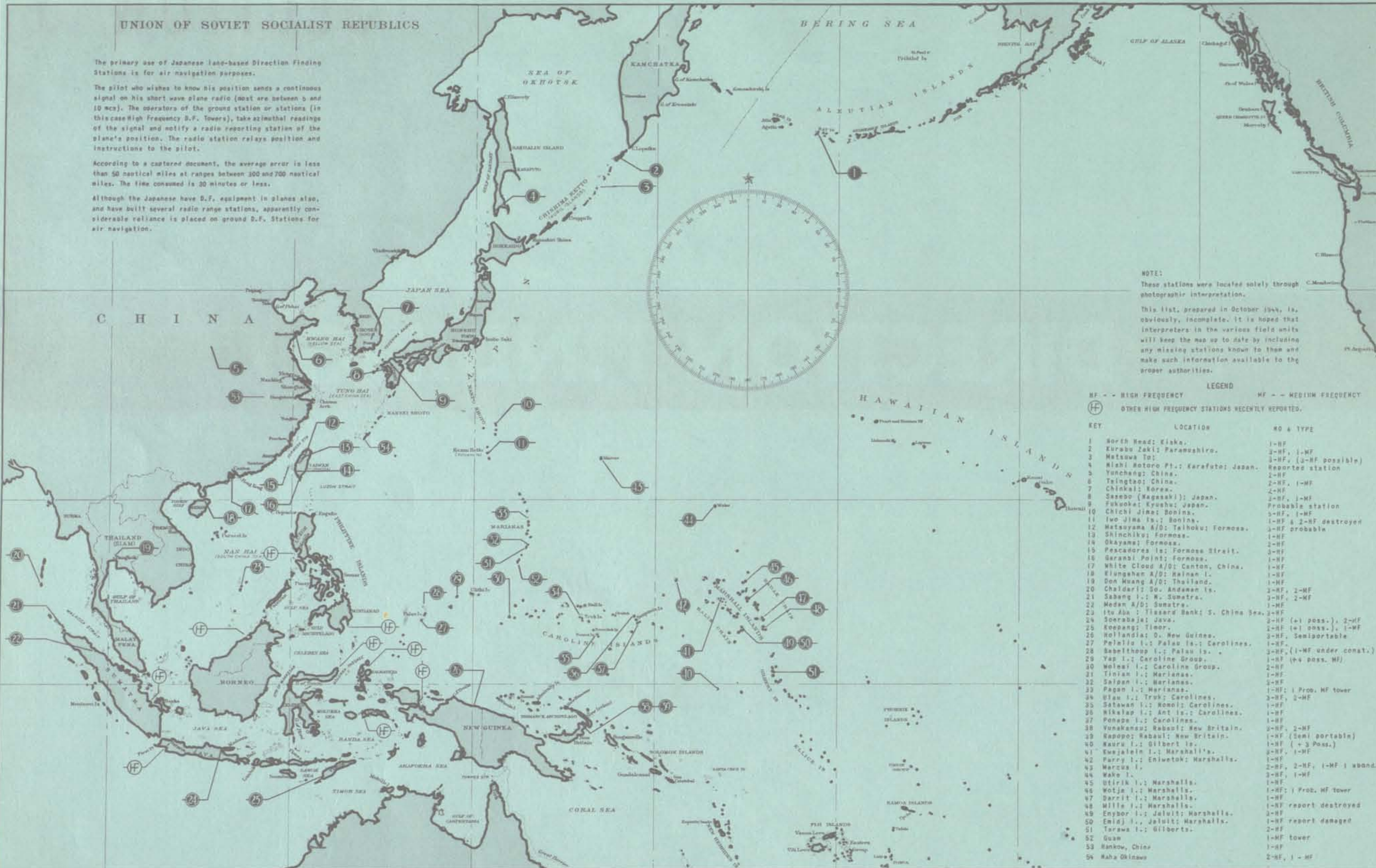
SUPPLEMENTARY MATERIAL

SECTION-3

3.01 — 3.99

DIRECTION FINDING

LOCATION OF JAPANESE DIRECTION FINDER STATIONS



The primary use of Japanese land-based Direction Finding Stations is for air navigation purposes.

The pilot who wishes to know his position sends a continuous signal on his short wave plane radio (most are between 5 and 10 mcs). The operators of the ground station or stations (in this case High Frequency D.F. Towers), take azimuthal readings of the signal and notify a radio reporting station of the plane's position. The radio station relays position and instructions to the pilot.

According to a captured document, the average error is less than 50 nautical miles at ranges between 300 and 700 nautical miles. The time consumed is 30 minutes or less.

Although the Japanese have D.F. equipment in planes also, and have built several radio range stations, apparently considerable reliance is placed on ground D.F. Stations for air navigation.

NOTE:

These stations were located solely through photographic interpretation.

This list, prepared in October 1944, is, obviously, incomplete. It is hoped that interpreters in the various field units will keep the map up to date by including any missing stations known to them and make such information available to the proper authorities.

LEGEND

HF - - HIGH FREQUENCY   MF - - MEDIUM FREQUENCY

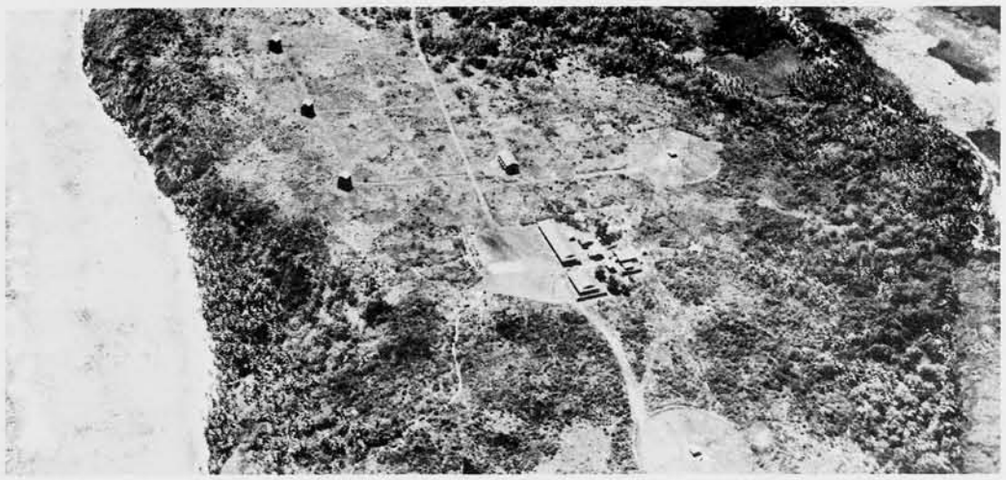
(HF) OTHER HIGH FREQUENCY STATIONS RECENTLY REPORTED.

KEY	LOCATION	NO & TYPE
1	North Head: Kiska.	1-HF
2	Kurabu Zaki; Paramushiro.	3-HF, 1-MF
3	Matsuwa To:	3-HF, (3-HF possible)
4	Nishi Notoro Pt.: Karafuto: Japan.	Reported station
5	Yuncheng: China.	2-HF
6	Tsingtao: China.	2-HF, 1-MF
7	Chinkai: Korea.	2-HF
8	Sasebo (Nagasaki): Japan.	3-HF, 1-MF
9	Fukuoka: Kyushu: Japan.	Probable station
10	Chichi Jima: Bonins.	5-HF, 1-MF
11	Iwo Jima Is.: Bonins.	1-HF & 2-HF destroyed
12	Matsuyama A/D: Taihoku: Formosa.	3-HF probable
13	Shinchiku: Formosa.	1-HF
14	Okayama: Formosa.	2-HF
15	Pescadores Is: Formosa Strait.	3-HF
16	Garanbi Point: Formosa.	1-HF
17	White Cloud A/D: Canton, China.	1-HF
18	Kiungshan A/D: Hainan I.	1-HF
19	Don Muang A/D: Thailand.	1-HF
20	Chaldari: So. Andaman Is.	3-HF, 2-MF
21	Sabang I.: N. Sumatra.	3-HF, 2-MF
22	Medan A/D: Sumatra.	1-MF
23	Itu Aba : Tissard Bank: S. China Sea.	3-HF
24	Soerabaja: Java.	3-HF (+1 poss.), 2-MF
25	Koepang: Timor.	2-HF (+1 poss.), 1-MF
26	Hollandia: D. New Guinea.	3-HF, Semiportable
27	Pelelie I.: Palau Is.: Carolines.	1-HF.
28	Babelthoup I.: Palau Is. .	3-HF, (1-MF under const.)
29	Yap I.: Caroline Group.	1-HF (+4 poss. MF)
30	Woleai I.: Caroline Group.	2-HF
31	Tinian I.: Marianas.	1-HF
32	Saipan I.: Marianas.	5-HF
33	Pagan I.: Marianas.	1-HF: 1 Prob. MF tower
34	Ulau I.: Truk; Carolines.	3-HF, 2-MF
35	Satawan I.: Nomoi: Carolines.	1-HF
36	Nikalap I.: Ant Is.: Carolines.	1-HF
37	Ponape I.: Carolines.	1-HF
38	Vunakanau: Rabaul: New Britain.	3-HF, 2-MF
39	Rapopo: Rabaul: New Britain.	1-HF (Semi portable)
40	Nauru I.: Gilbert Is.	1-HF (+ 3 Poss.)
41	Kwajalein I.: Marshall's.	3-HF, 1-MF
42	Parry I.: Eniwetok: Marshalls.	1-HF
43	Marcus I.	2-HF, 2-HF, 1-MF 1 aband.
44	Wake I.	3-HF, 1-MF
45	Utirik I.: Marshalls.	1-HF
46	Wotje I.: Marshalls.	1-HF: 1 Prob. MF tower
47	Darrit I.: Marshalls.	1-HF
48	Mille I.: Marshalls.	1-HF report destroyed
49	Enybor I.: Jaluit: Marshalls.	3-HF
50	Emidj I., Jaluit: Marshalls.	1-HF report damaged
51	Tarawa I.: Gilberts.	2-HF
52	Guam	1-HF tower
53	Hankow, China	1-HF
54	Naha Okinawa	2-HF, 1 - MF

[redacted]DENTIAL

DIRECTION FINDING
SUMMARY

Direction finders are RECEIVERS of radio signals. They are equipped to determine the direction from which such radio signals are being sent. D.F.ing is possible on any transmitting equipment operating in the same frequency band as the D.F. receiver.



D.F. STATION AT TRUK

D.F. installations are used on aircraft and on naval vessels as well as on land. This section, however, deals primarily with fixed land installations. D.F. is often used by the Japanese as an aid to aerial navigation in addition to its use for intelligence purposes. In such cases the customary procedure is as follows:

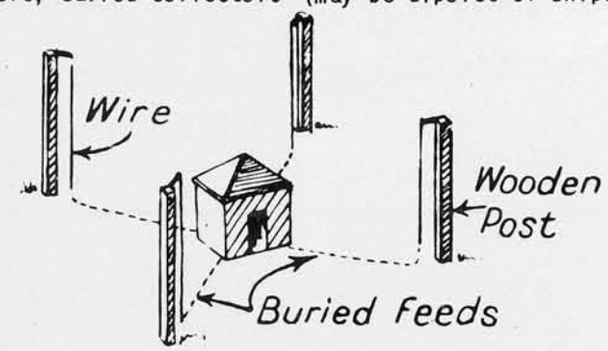
When Japanese pilots desire bearings from these stations, they hold down on the key sending a continuous signal on which an azimuth reading is taken by the D.F. operator. The bearing is then transmitted to the pilot via a radio communications station which is usually found near a D.F. installation.

TYPES OF D.F.

There are two basic types of direction finders - the loop and the Adcock. Although the loop method is used on aircraft and ships, the majority of Japanese land based D.F. stations photographed to date operate on the Adcock system.

ADCOCK

The Japanese style Adcock, in simplest form, may be described in this manner: Four vertical members arranged in a square, with the receiver in the center, and with diagonal electrical connections between the center and all four vertical members, called collectors (may be dipoles or unipoles).



This arrangement is augmented by a central sensing antennae (frequently not visible but which determines the direction of the signal after the line of bearing has been established.)

Example: When the unipoles determine the signal to be on 10^{o} - 190^{o} line the central sensing antennae indicates whether the signal is coming from 10^{o} or from 190^{o}.

This type may also be referred to as "fixed Adcock" in that the unipoles or dipoles do not rotate. It may be either completely housed or the collectors may be exposed.

As in Radio Communications, D.F. is catalogued by frequency. The common types are in the High and Medium frequency ranges.

TABLE OF FREQUENCIES

FREQUENCY	UNIPOLE OR (DIPOLE) DIAGONAL SPACING	UNIPOLE (OR DIPOLE) HEIGHT	WAVE LENGTH IN METERS	FREQUENCY IN MEGACYCLES PER SEC.
HIGH ("HOUSED ADCOCK")	20' TO 30' (MOST ARE 25')	15' TO 25'	100 TO 10 M	3 TO 30 MCS.
MEDIUM ("OPEN ADCOCK")	90' TO 150' (MOST ARE 100')	50' TO 75'	1000 TO 100 M	0.1 TO 3 MCS.

DIRECTION FINDING

SUMMARY (CONT.)

SPACING AND HEIGHT OF UNIPOLES

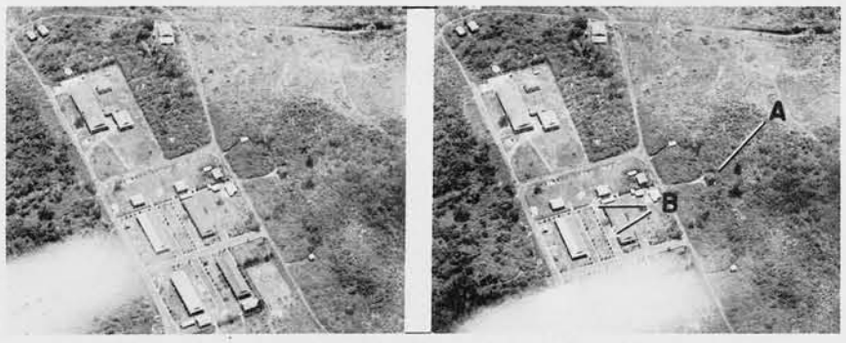
The frequency of Adcock type D. F. is determined by the photographic interpreter from the spacing and height of the collectors (unipoles or dipoles).

Rule of thumb method for determining wave length:

$$\text{Minimum wave length in meters} = \frac{\text{diagonal distance between collectors}}{0.2}$$

Translation to frequency:

$$\text{Frequency in Kilocycles} = \frac{300000}{\text{Wave length in meters}}$$



PONAPE, CAROLINES

Example of High Frequency D. F. with Radio Reporting Station nearby.

D. F. CENTERS

Many D. F. centers have easily recognizable "T", "H", or "L" shaped buildings which contain offices, communications, barracks, baths, messing facilities, power plant, storage etc.

The various elements are one story in height and are connected by narrow covered passageways.

DARRITT, MAJURO, MARSHALLS

General Notes on Japanese D. F.

1. Located near airfields (and other locations).
2. Site is well cleared, fairly level and high.
3. Pattern of roads and paths connecting installations, usually visible.
4. Radio communications station (reporting station) is always present or near at hand.
5. High and Medium frequency set-ups are usually present in combination at important D. F. centers.
6. A Japanese D. F. center usually consists of:
   - (a) high frequency installation, or
   - (b) two high frequency installations, or
   - * (c) three high frequency installations, or
   - (d) one medium frequency installation, or
   - * (e) two medium frequency installations, or
   - (f) combinations of high and medium frequency up to a usual maximum of three high and two medium.

* = most often found

NOTE: D. F. stations at Chichi Jima and at Matsuwa have 6 H. F. Towers. These cases, however, are exceptional and were the result of additions to the original stations.

DUPLICATION OF INSTALLATIONS

The Japanese frequently build duplicate installations of the same frequency on the same site. The building arrangement is considered as having no particular electrical significance.

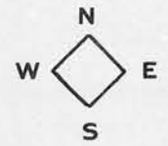
Probable reasons:

1. To operate at slightly different frequencies at the same time within a given frequency range.
2. For security reasons - in the event of damage or breakdown of equipment.
3. When spread out over long distances they may be used to locate objective by triangulation.

ORIENTATION

The preferred method of orientation is as follows:

Open Adcock



Housed Adcock

Ordinarily, D. F. installations are constructed with a definite relationship to North. The sides of all buildings usually fall in a constant relation to North and therefore, are parallel to each other.

It is an advantage, when constructing D. F. stations, to establish and incorporate the direction of North into the construction of collectors at an early stage. Thus, when the layout is installed, the calibrations for azimuth readings are easily related to a fixed reference line.

HIGH FREQUENCY ADCOCK

The Japanese usually construct the high frequency Adcock in a house which encloses the dipoles within its walls, one set of dipoles being in each corner.

This installation which is called "Housed Adcock" has been standardized to some extent in use throughout the Pacific Islands.

PATTERNS

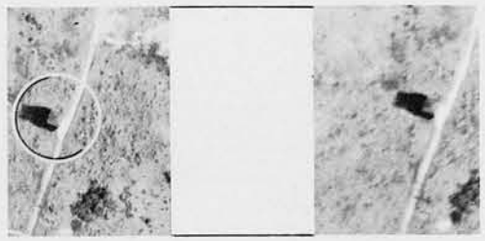
Although found in ones, twos, and threes, most stations have three Housed Adcocks arranged in a triangle or on a straight line. Arrangements vary to such an extent that identification cannot be based on pattern.

The type most often found is identified best by the following key dimensions:
Plan view - 23' x23' (including roof overhang). Interior - 20' x20'.
Height - 32' (from ground to eave)
Buttresses - 5' spread at base

* (Note: Hereafter, this type of station will be called a "Housed Adcock" or "High Frequency D. F. tower".)

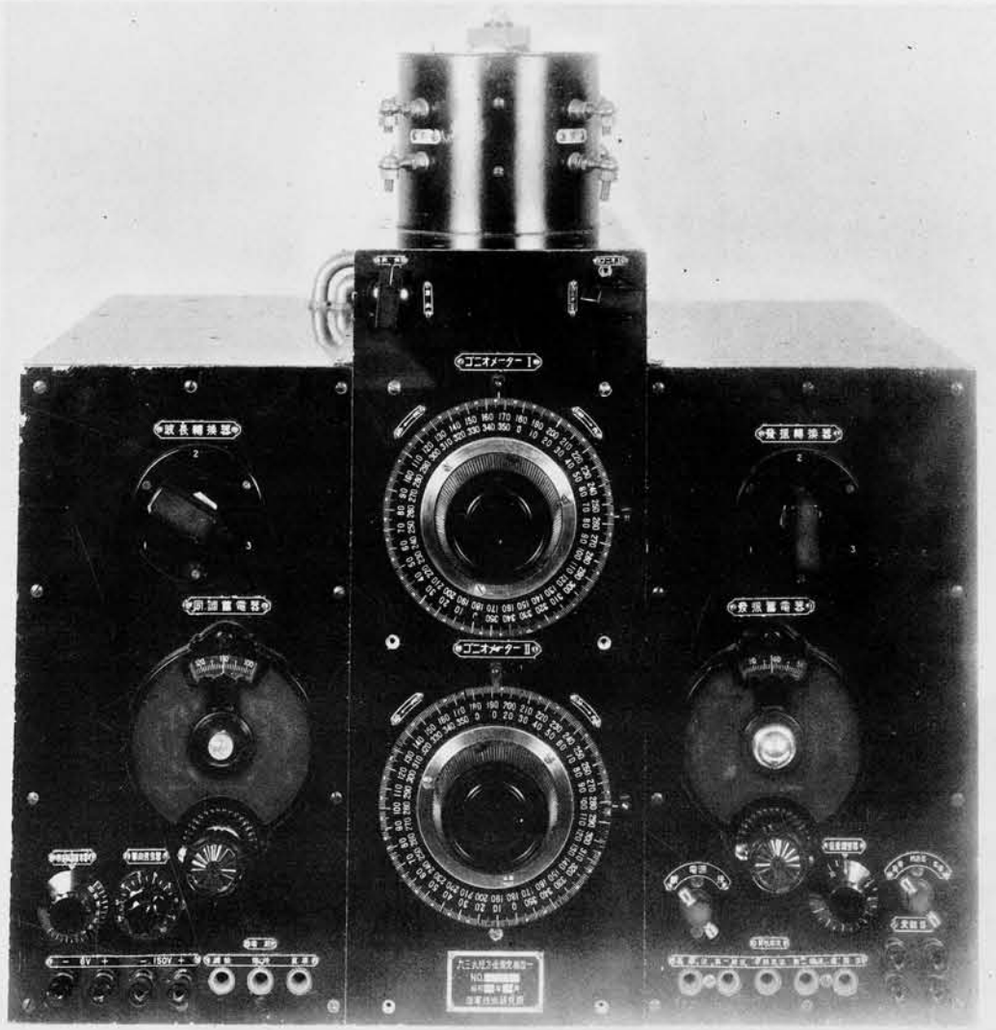
RIGHT: Front view of High Frequency D. F. Receiver. Connections with dipoles are made at the top of instrument which is surmounted by the central sensing antennae. Goniometers are used to determine direction instead of rotating the dipoles which are fixed in the corners of the building.

BELOW: High Frequency D. F. tower at Kwajalein. The receiver, dipoles, and operator's table are all enclosed within the walls of this structure. The buttresses, for some unknown reason, are usually present on D. F. towers.



KWAJALEIN

KWAJALEIN



JAPANESE HIGH FREQUENCY D. F. RECEIVER

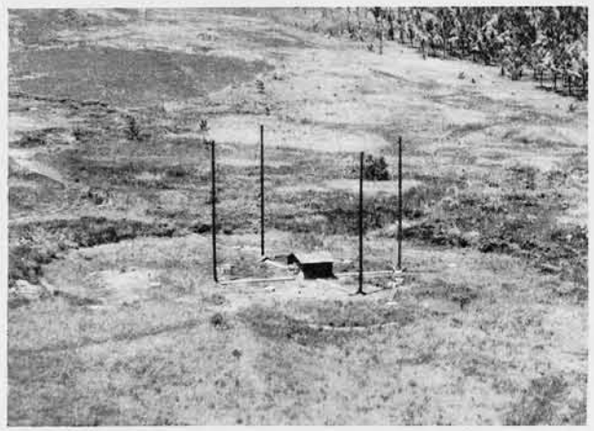
MEDIUM FREQUENCY ADCOCK

Most Japanese Medium Frequency Adcock D. F. stations ("Open Adcock") may be identified by the following keys:

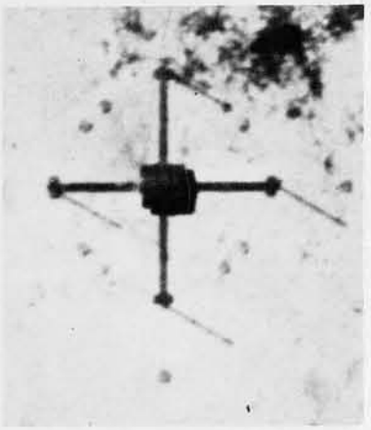
1. Four stick masts (unipoles) arranged in a square pattern.
2. Small hut in center approximately 20 feet square.
3. Strongly visible diagonal lines (cables) connecting unipoles.
4. Diagonal distance between unipoles is approximately 100 feet.
5. 12 Square concrete blocks 3' x3' anchoring guy wires.

The Medium Frequency Adcock operates in a similar manner to the High Frequency, the main difference being the greater distance between vertical antennae elements which is necessary for efficient medium frequency reception.

The four stick masts found with this installation are called unipoles, electrical connections being made by means of buried feeds leading from each pole to the central hut or shack.



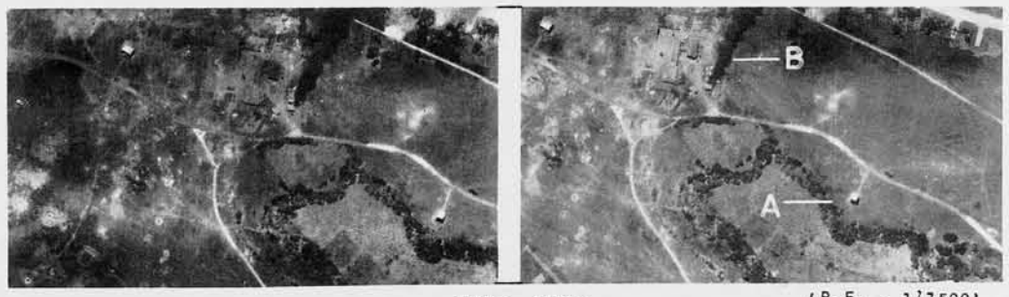
VUNAKANAU, RABAUL, NEW BRITAIN



WAKE

DIRECTION FINDING
SUMMARY (CONT.)

IWO JIMA



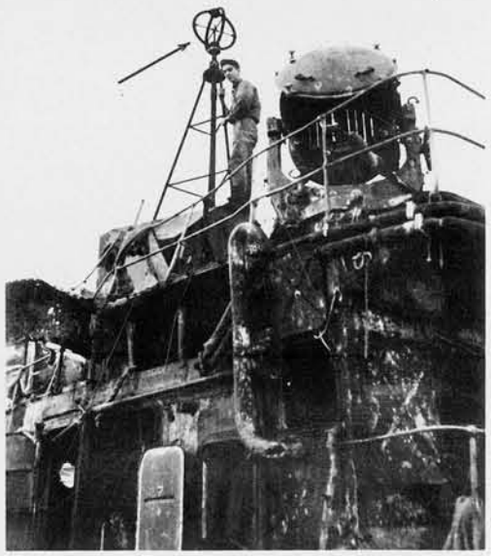
IWO JIMA (R.F. - 1/7500)

"A" - TYPE I HIGH FREQUENCY D.F. TOWER
"B" - D.F. CENTER WITH MEDIUM FREQUENCY RADIO REPORTING STATION

BELOW, LEFT: Two Direction Finding towers at Pagan. The height of the left tower is 32 feet (from ground to eave) while the right tower is about 22 feet high. The short tower design is not used to a great extent, and is thought to house a Naval type Medium Frequency loop D.F. equipment.

BELOW, RIGHT: Medium Frequency loop type D.F. antennae used on Japanese naval vessels.

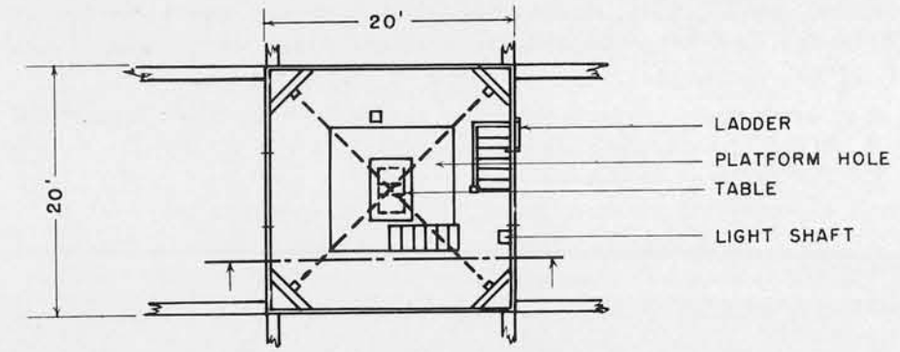
PAGAN, MARIANAS

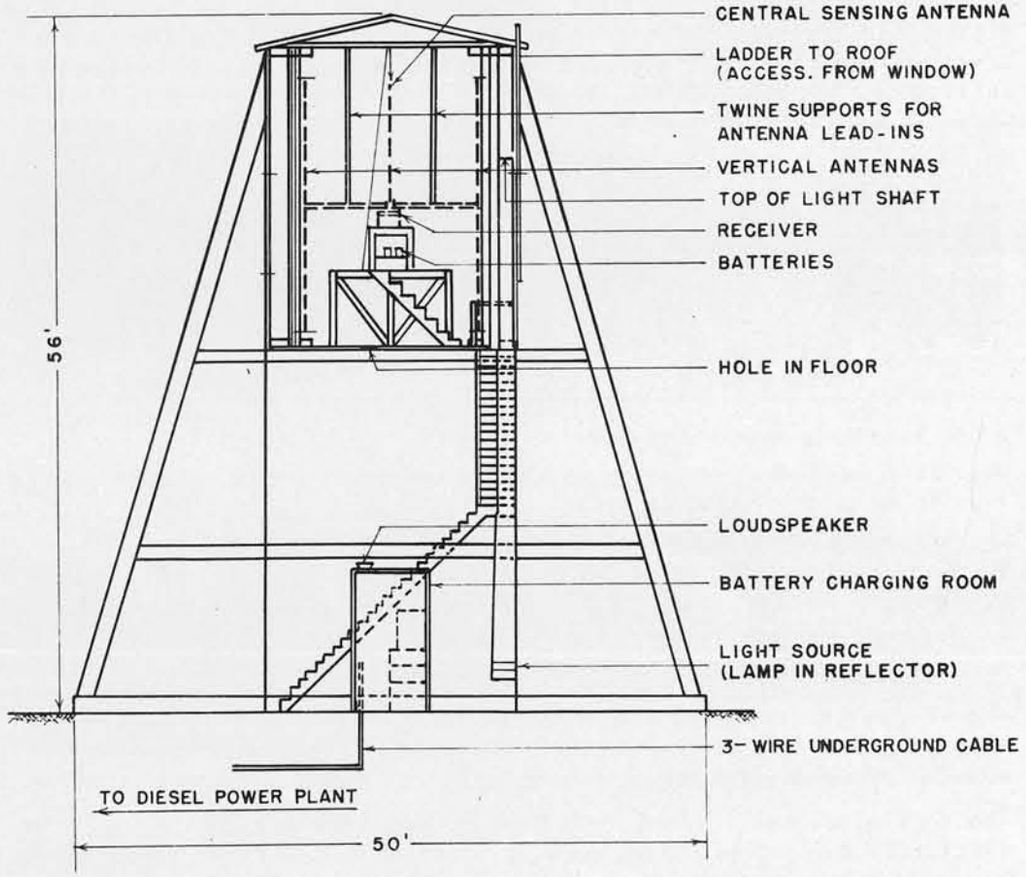


DIRECTION FINDER ON D.D.

BELOW: The drawing below was made from a High Frequency D.F. tower at Tarawa. It is not a typical design in that it is higher than any others seen to date. However, it is thought that the basic principles of the interior design are characteristic of most Japanese High Frequency D.F. towers.

As can be seen from this diagram, each D.F. tower requires an operator.

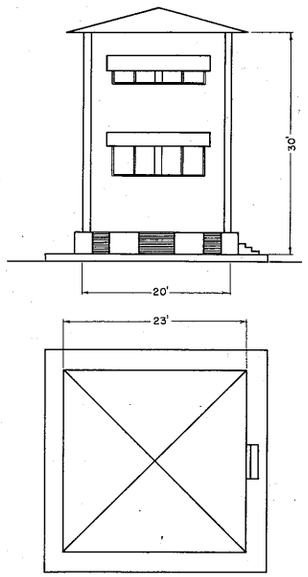




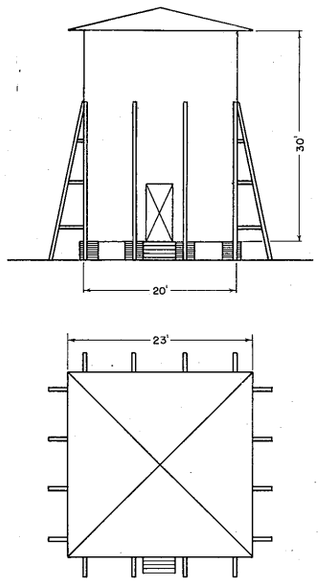
CONFIDENTIAL

DIRECTION FINDING

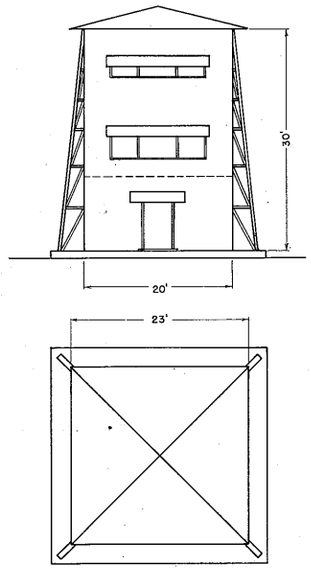
SUMMARY (CONT.)



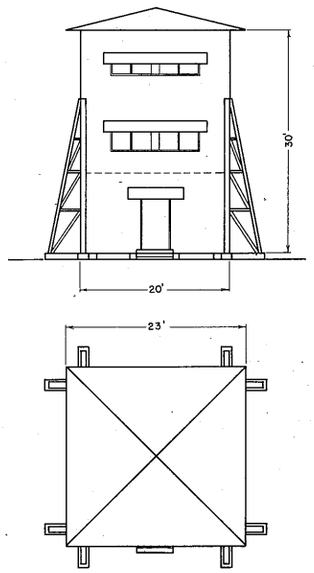
TYPE 1



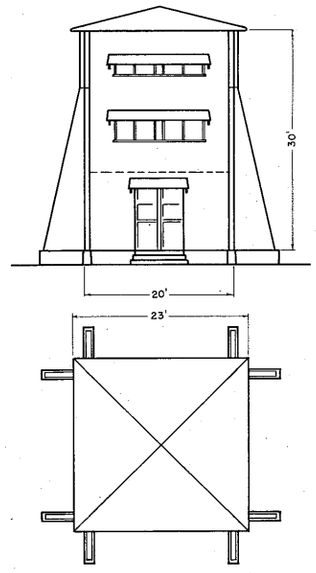
TYPE 2



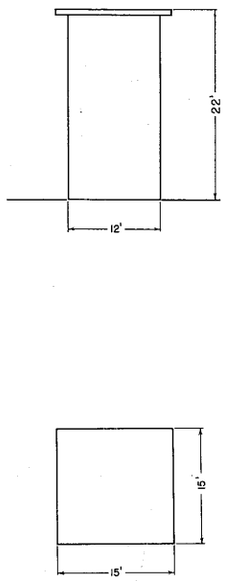
TYPE 3



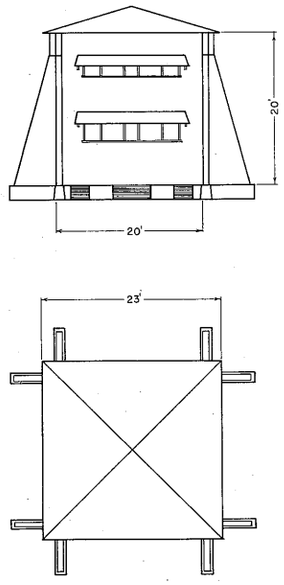
TYPE 4



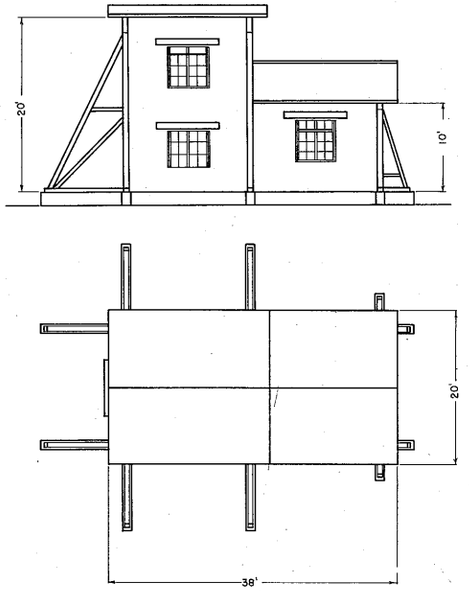
TYPE 5



TYPE 6



TYPE 7



TYPE 8

On this page are shown eight D. F. tower designs in use by the Japanese. Types "1", "2", "3", "4", and "5" are thought to enclose High Frequency Adcocks. These structures are 20' square by 30'-32' high.

Types "6", "7", and "8" are thought to enclose Medium Frequency rotating loop D. F. (similar to naval type). The loop type may be used in a structure with a floor plan of less area than High Frequency fixed Adcock. A 12 foot square plan would allow sufficient space. The best clue, however is in the height of the structure. 18-20 feet of height is sufficient for a loop type, but is not considered enough for a High Frequency fixed Adcock.

Elaborate buttress systems characterize many of these designs. The towers are capable of withstanding abnormally high winds.

The towers shown were reconstructed from aerial photographs and not to be regarded as examples of detailed accuracy - but merely key information for identification purposes.

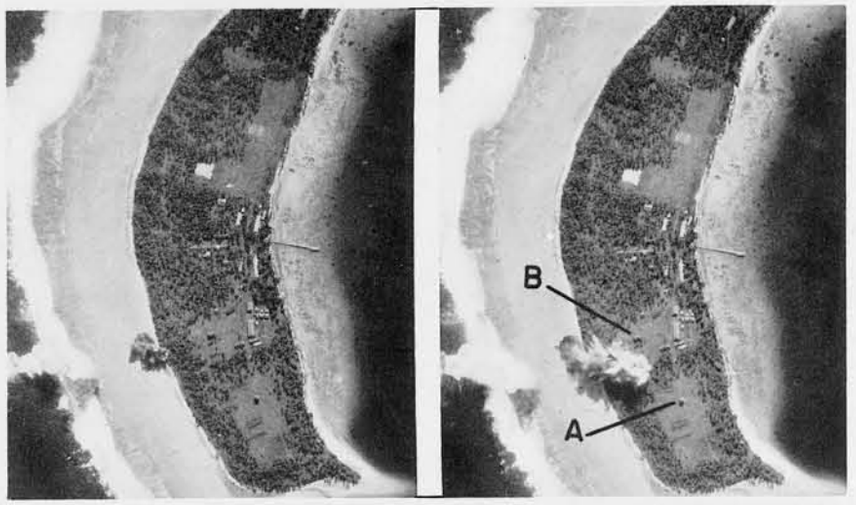
[redacted]

DIRECTION FINDING
HIGH FREQUENCY

MAJURO

This D.F. set up, when captured on Darritt Island, Majuro, had been abandoned before equipment was installed in the buildings. However, due to the fact that no damage resulted from the occupation, these provide a good opportunity for studying the architectural details of the most recent D.F. building design. Note the finished appearance of the Structures, in which even the buttresses are sheathed with clapboards. This is type "5".

MAJURO

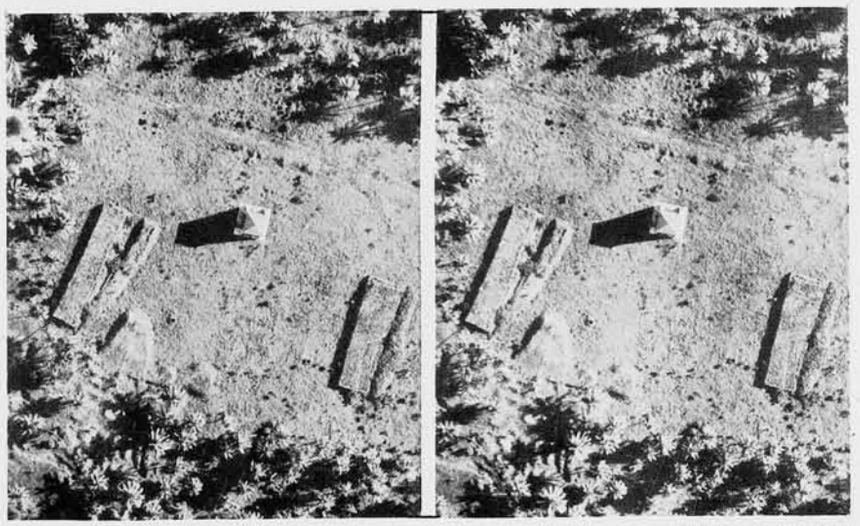


(R.F. - 1/17000)

MAJURO

Above: "A" = High Frequency D.F., "B" - Probable Generator Building

Below are close ups of the two structures erected on Darritt. The one at the left was designed to house the High Frequency D.F. equipment. The building at the right is a standard type, seen usually with large D.F. centers and is thought to be a generator building. However, it may contain a D.F. receiver. This, however, has not been determined from ground information as yet. Approximate dimensions are length -38', width 32', height 22'.



(R.F. - 1/2200)

MAJURO

The above Stereogram shows quite clearly the important identification characteristics of the High Frequency D.F. tower. The hipped roof is 23' to 24' square (including overhang). Height, from ground to eave is 32'. The buttresses, spreading 6' at the base are clearly visible here.

MAJURO
High Frequency D.F. tower
Note that there is but one floor above the ground floor.

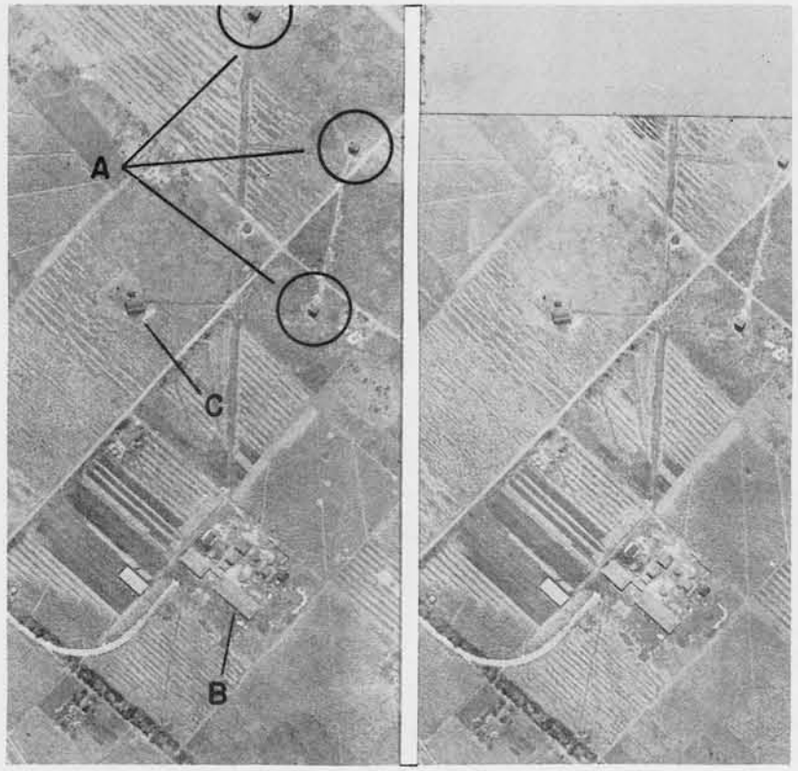
MAJURO
Unidentified. Probable Generator Building
This structure was empty when our troops took over Majuro.

CONFIDENTIAL

DIRECTION FINDING
HIGH FREQUENCY (CONT.)

JALUIT, MARSHALLS

Type "5" similar to Majuro tower but without window sun shades. Roof is hipped and measures 23' x 23' in plan, including overhang.

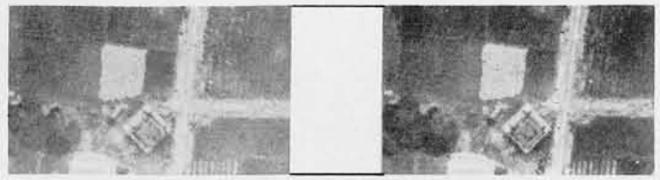


(R.F. - 1/6000)

SAIPAN, MARIANAS

"A" - High Frequency D.F.
"B" - D.F. Center
"C" - Probable Generator Building

A High Frequency D.F. Station on Saipan. Complete with D.F. center and large (probable) generator building. It is more usual to find one or two Medium Frequency installations, in addition to the High Frequency towers, with this size station. Contents of "C" have not been reported as yet.



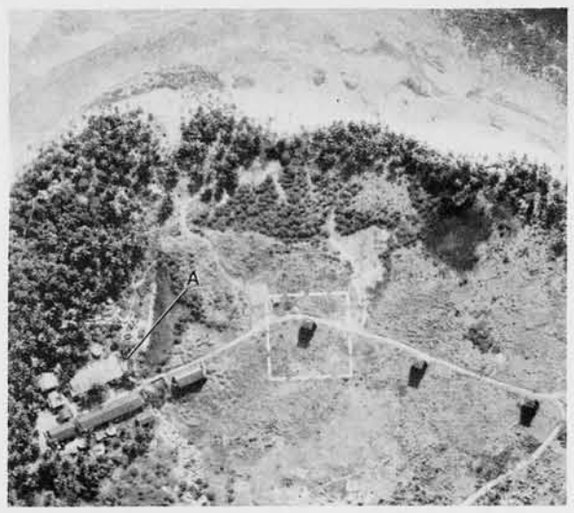
(R.F. - 1/2200)

TINIAN, MARIANAS

Type "4" tower with hipped roof and wooden sun shades. The pattern on the roof presents an unusual appearance in this view.

VUNAKANAU, RABAUL

Type "4" High Frequency D.F. tower with hipped roof at Rabaul. This is one of three which are used.



(R.F. - 1/3500)

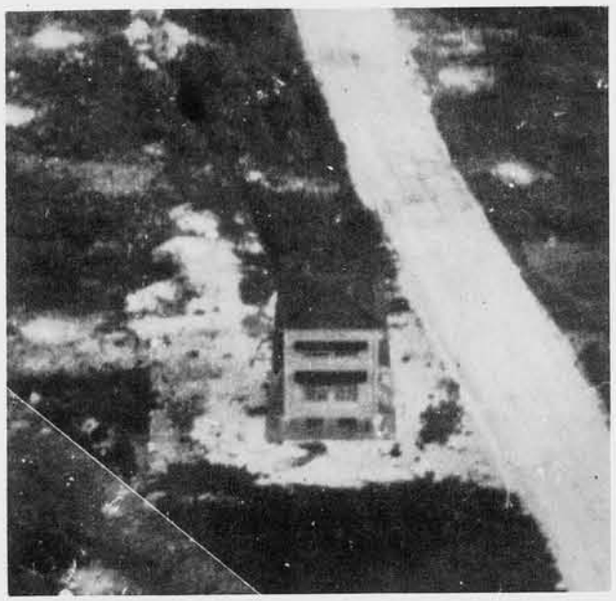
JALUIT, MARSHALLS

Vertical view of all three towers in the Jaluit Direction Finding Station. Note the "in line" pattern, road connection to all towers and probable generator building at left.

ULALU, TRUK

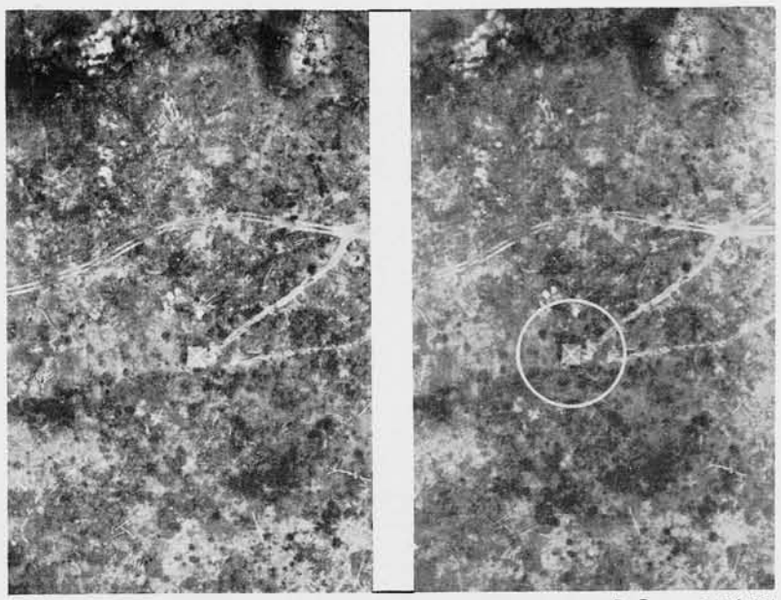
Type "4" tower with pitched roof and wooden sun shades. Note that road or path is always visible at operative stations.

DIRECTION FINDING
HIGH FREQUENCY (CONT.)



WAKE

Tower on Wake, Type "I", was one of the earliest examples found of Japanese High Frequency D.F. towers. Note the absence of buttresses.



(R.F. - 1/2600)

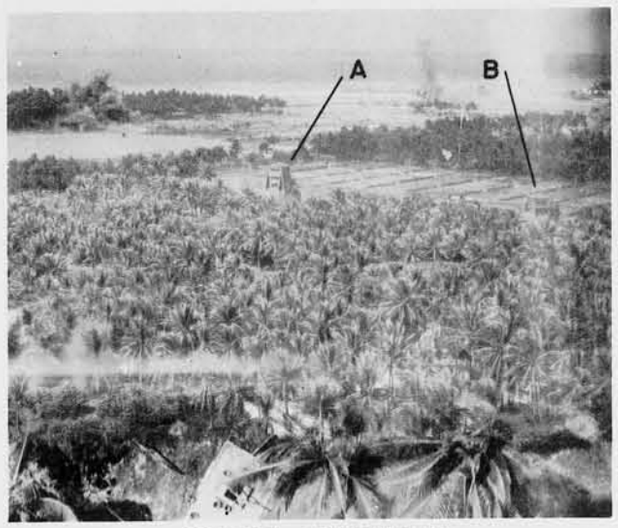
MILLE, MARSHALLS

This installation at Mille is unusual in construction. The four rows of buttress type braced on each side have not been seen elsewhere. Apparently, construction was not complete when these pictures were taken.

(R.F. - 1/4700)

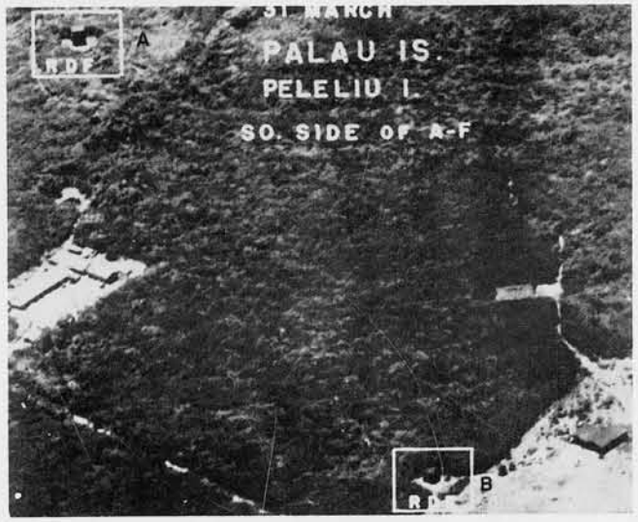
ITUABA, TISSARD BANK

It is difficult to determine the exact design of these towers due to the unusual shadow pattern. This equilateral triangle pattern is often found. Distance between towers is 350'.



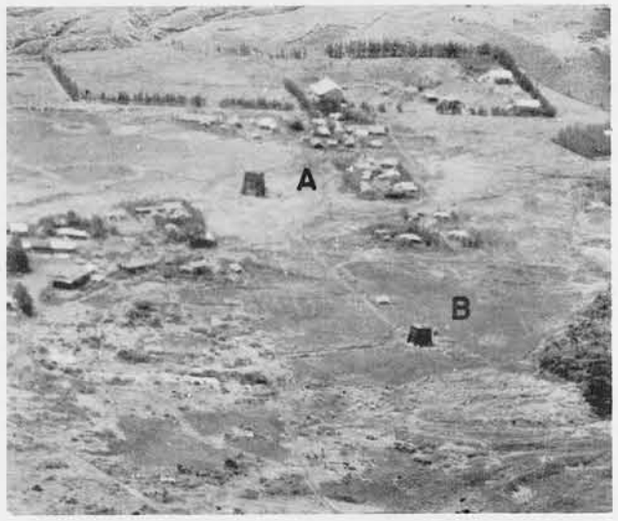
WOTJE, GILBERTS

"A" - High Frequency D.F. tower
"B"-Probable Medium Frequency tower (loop type)



PALAU

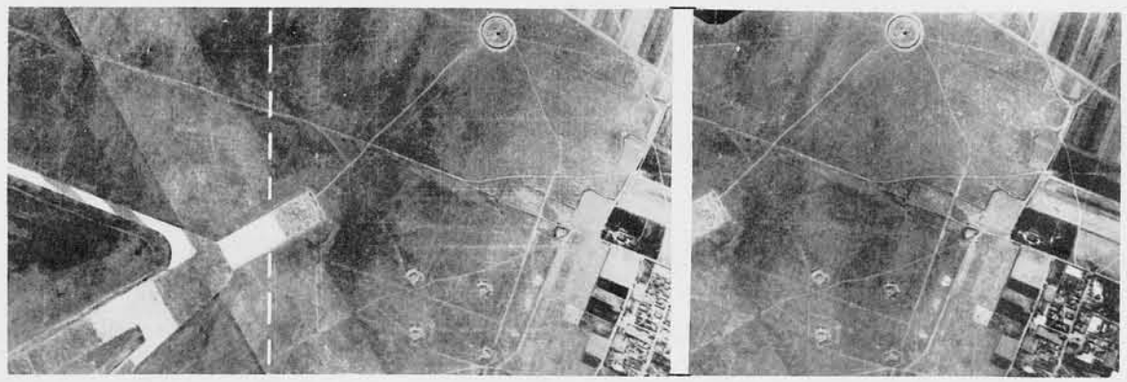
"A" - High Frequency D.F. tower
"B"-Probable Medium Frequency tower (loop type)



PAGAN, MARIANAS

"A" - High Frequency D.F. tower
"B" Probable Medium Frequency tower (loop type)

These examples, at Wotje, Palau, and Pagan, illustrate a lower design of tower which is occasionally found with the 32' high standard tower. These low towers are approximately 22 feet high, from ground to roof eave, and probably enclose Medium Frequency loop type D.F. apparatus operating best between 100 and 2000 Kcs.



YUNCHENG, CHINA (R.F. - 1/13000)

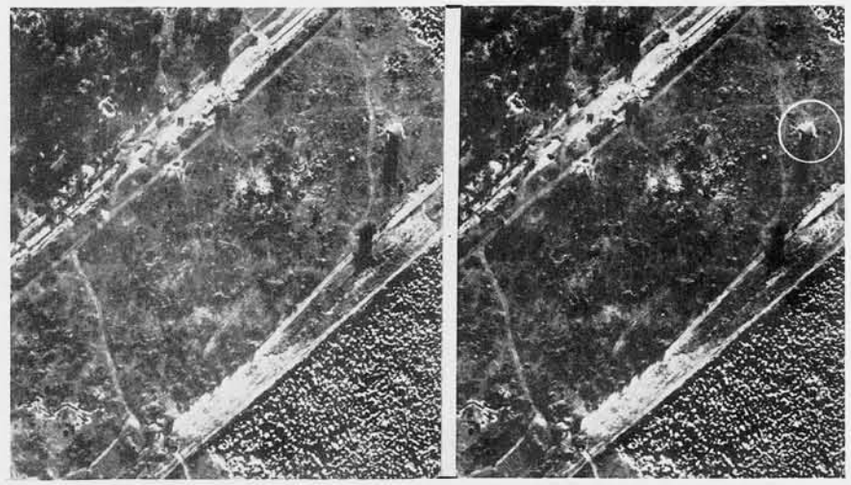
The installation shown above appears, at first glance, to resemble a fuel storage tank emplacement. However, upon closer examination, it is found to be a structure which resembles a typical D.F. tower, surrounded by a dike for protection against flood water.

HANKOW, CHINA (R.F. - 1/13000)

Probable High Frequency D.F. tower set in a square enclosure which appears to be a protective dike.

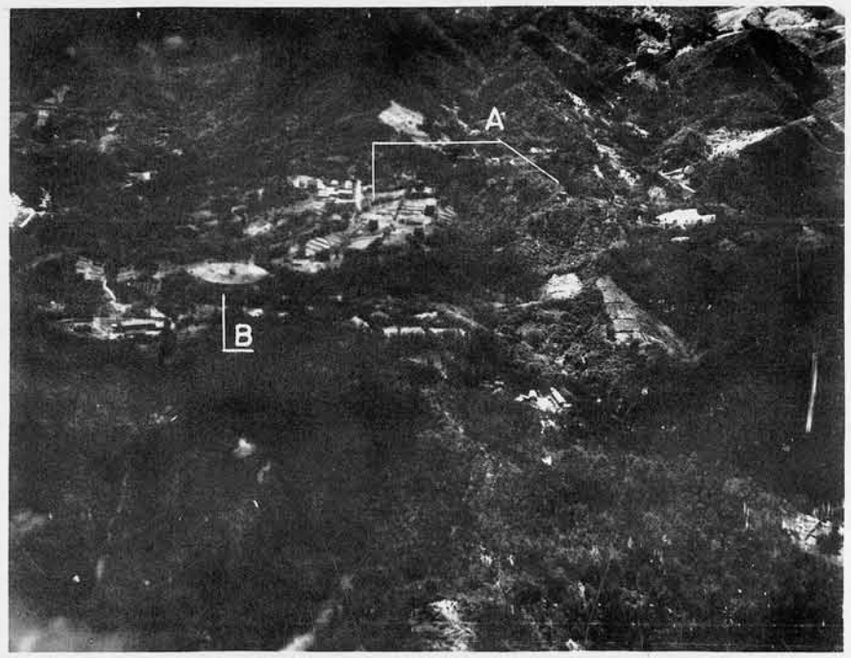
"A" - End of runway.

"B" - Unidentified tower, possibly High or Very High Frequency D.F.



NAURU (R.F. - 1/5000)

Type "3" D.F. tower. Note single corner buttresses.



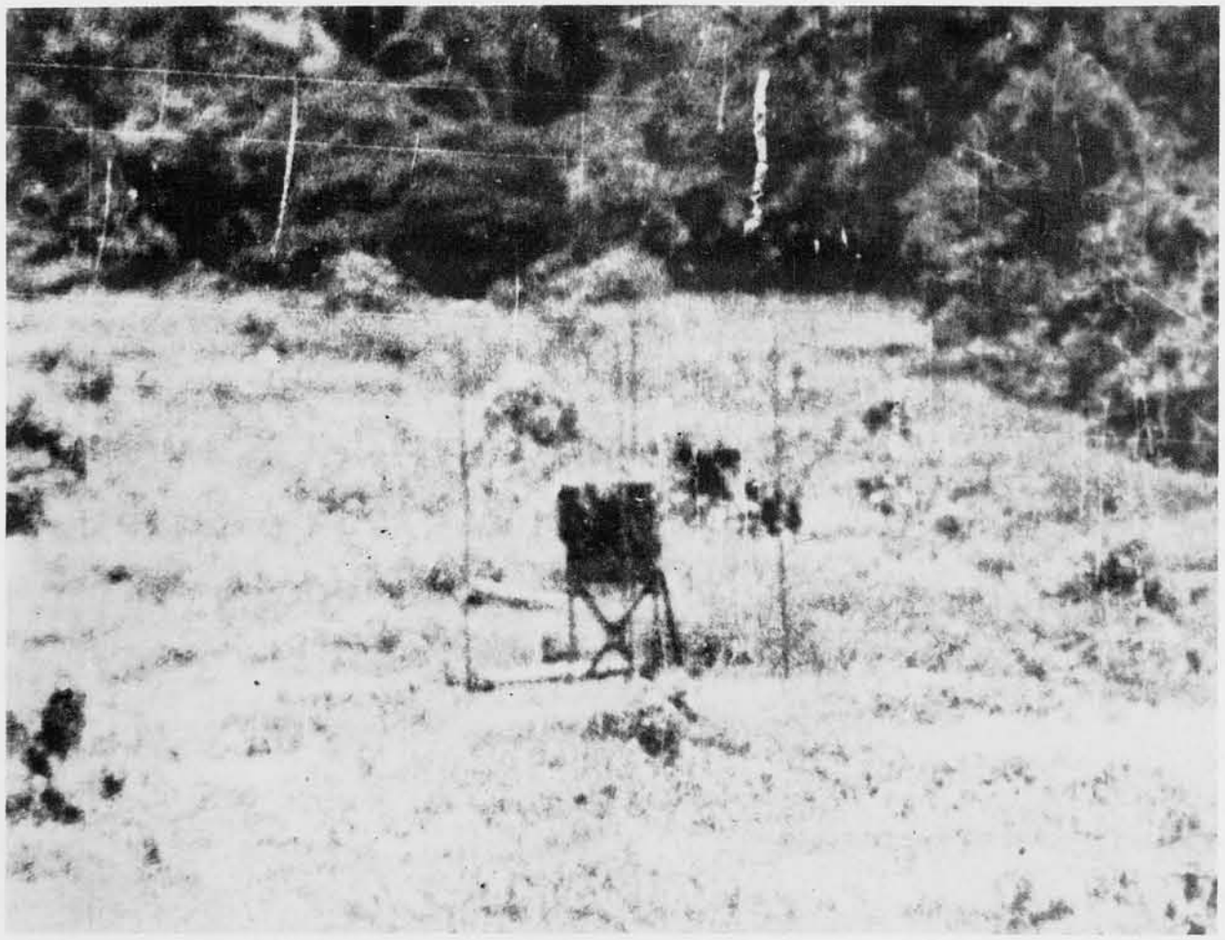
CHICHI JIMA, BONIN IS.

"A" - Six high frequency D.F. towers

"B" - One Medium Frequency D.F.

This is one of the very few examples of a group of more than three D.F. towers on the same site. Normally, if more than three towers are used on an airfield, they are widely separated.

DIRECTION FINDING
HIGH FREQUENCY (CONT.)



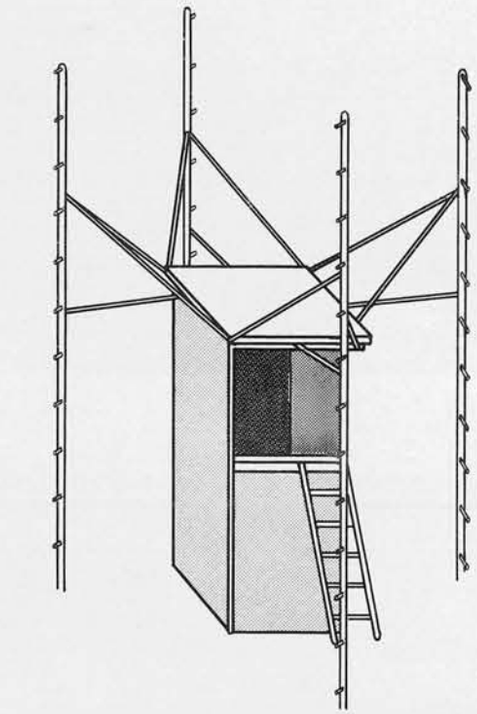
RAPOPO, NEW BRITAIN

This installation, observed at Rapopo and at Hollandia, is apparently a semi-portable type of High Frequency D.F. in the upper part of the High Frequency band.

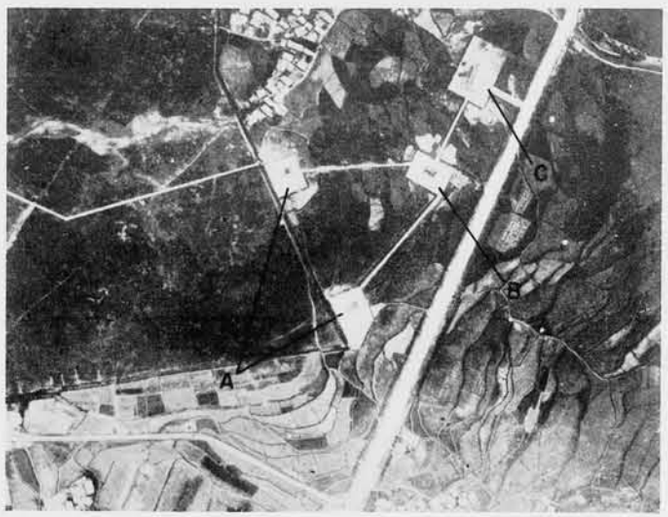
The diagonal distance between poles is approximately 18 feet. Poles are 25 feet high. These are very difficult to pick up at small scale photography, the operator's tower being only 7 or 8 feet square in the plan view.

This structure is probably not a standard new type but a portable adaptation of the Mark I, Model 2 D.F. receiver as used in the "Housed Adcocks".

RIGHT: At Hollandia, three of these installations were used near the airfield in an irregular pattern, spaced a few hundred feet apart.



HOLLANDIA, NEW GUINEA

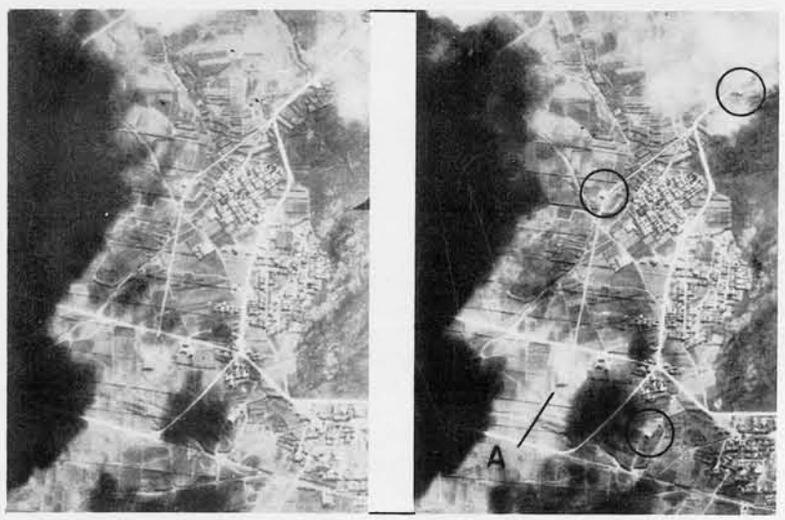


CHINKAI, KOREA (R.F. - 1/6000)

This station in Korea contains (A) 2 High Frequency towers, (B) probable generator building, (C) D.F. center. The distance between towers is about 500'.

Patterns of arrangement may assume many different forms. However, road connections to the towers and cleared areas near the instrument create unmistakable patterns.

RIGHT: The D.F. center ("A") with this installation appears to be partially buried. The High Frequency towers are 1200' and 1800' apart.



PESCADORES IS. (R.F. - 1/16250)

DIRECTION FINDING
MEDIUM FREQUENCY

The Japanese Medium Frequency (0.1 to 3 mcs.) Adcock type Direction Finder is shown on these and the following pages. It is designed for receiving and locating Medium Frequency transmitters.

Diagonal distance between unipoles	100'
Height of unipoles	60'-70'
Plan size of central shack	20' x20'
Height of central shack (ground to eave)	8'
Plan size of concrete anchors (12 in no.)	3' x3'
Average diameter of circular clearing	250'

This view shows clearly the Receiver Shack, covered cable connections, guy wires, and concrete anchors. The cable connections and concrete blocks are good recognition features at scales of 1/15000 and over, in cases where the poles are not readily seen.

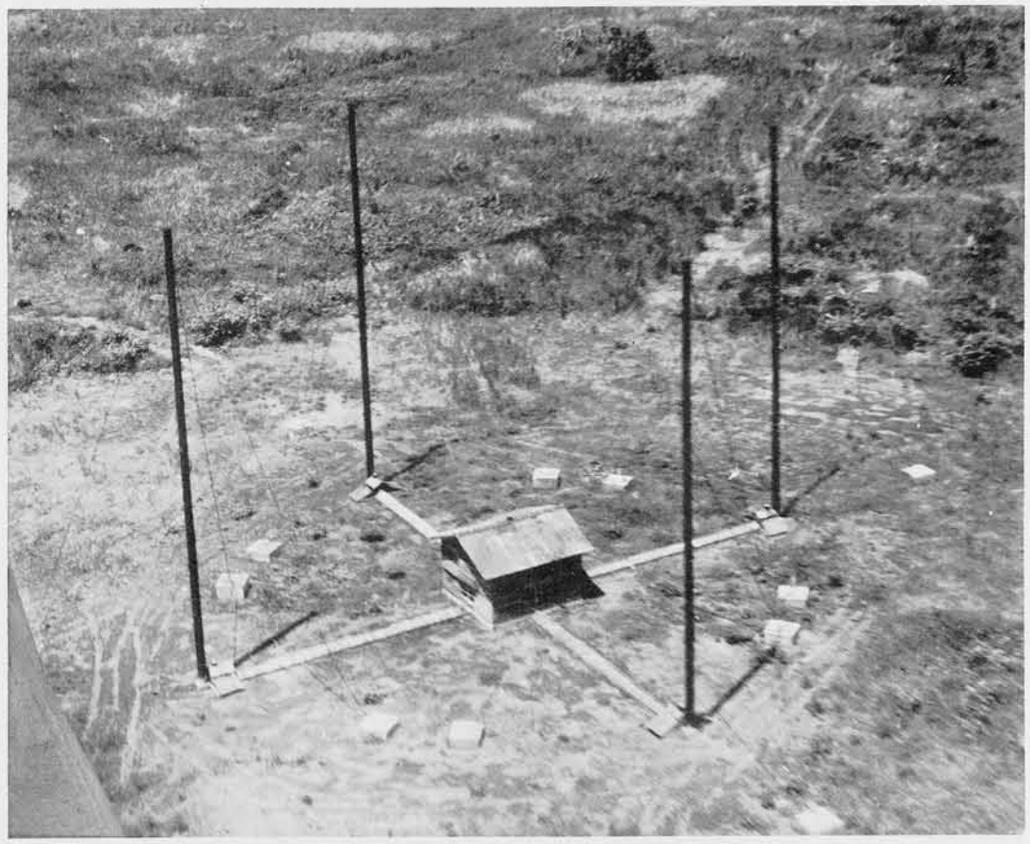
When a Medium Frequency D.F. is found, it will usually be accompanied by High Frequency towers. However, the reverse is not true, in that High Frequency towers are often found alone.

Recently, a rotating loop type D.F., such as is found on naval vessels (see page 3.04), has been discovered in use as a Medium Frequency land installation.

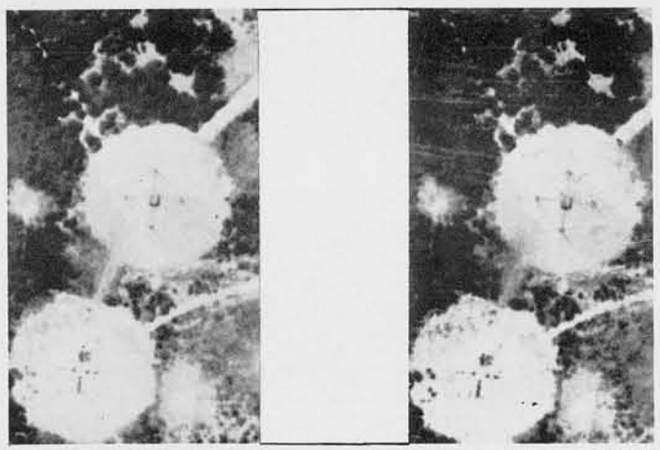
In this instance, the naval type loop was fitted into a wooden tower, resembling the standard Japanese High Frequency towers, but smaller. Tower was 12 feet square and 18 feet high.

The loops are slightly less than 3 feet in diameter and connected to a metal shaft leading down to the operator's table, 13 feet below the loop.

It is thought that this installation can D.F. on frequencies between 100 KCS and 2000 KCS, but is less efficient than the fixed Adcock type shown on this page.

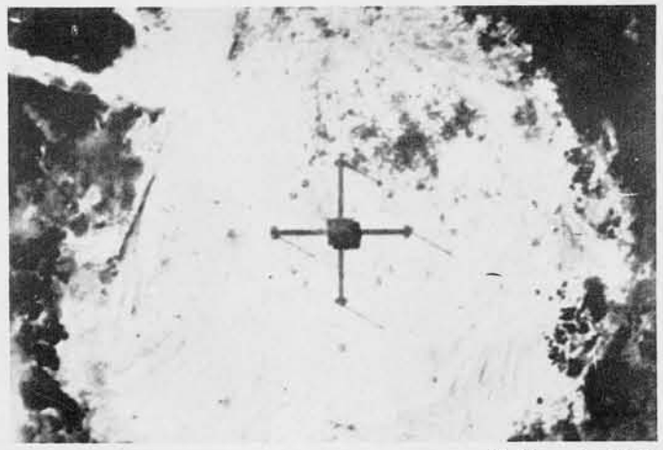


VUNAKANAU, RABAUL, NEW BRITAIN



MARCUS (R.F. - 1/3600)

Medium Frequency equipment is often found as twin installations. This setup at Marcus shows two unmistakable circular clearings of 250' diameter which characterize the Japanese Medium Frequency Adcock.



WAKE (R.F. - 1/1800)

Note that the covered cable connections, in this case, photograph dark in tone. Pattern is made up of crossing cable lines, central shack, concrete anchors, poles and clearing (usually circular).

VUNAKANAU, RABAUL, NEW BRITAIN

View showing both of the medium frequency D.F. installations at the Vunakanau Airfield. Three high frequency towers (not shown here) are also present at this station.

DIRECTION FINDER
MEDIUM FREQUENCY (CONT.)

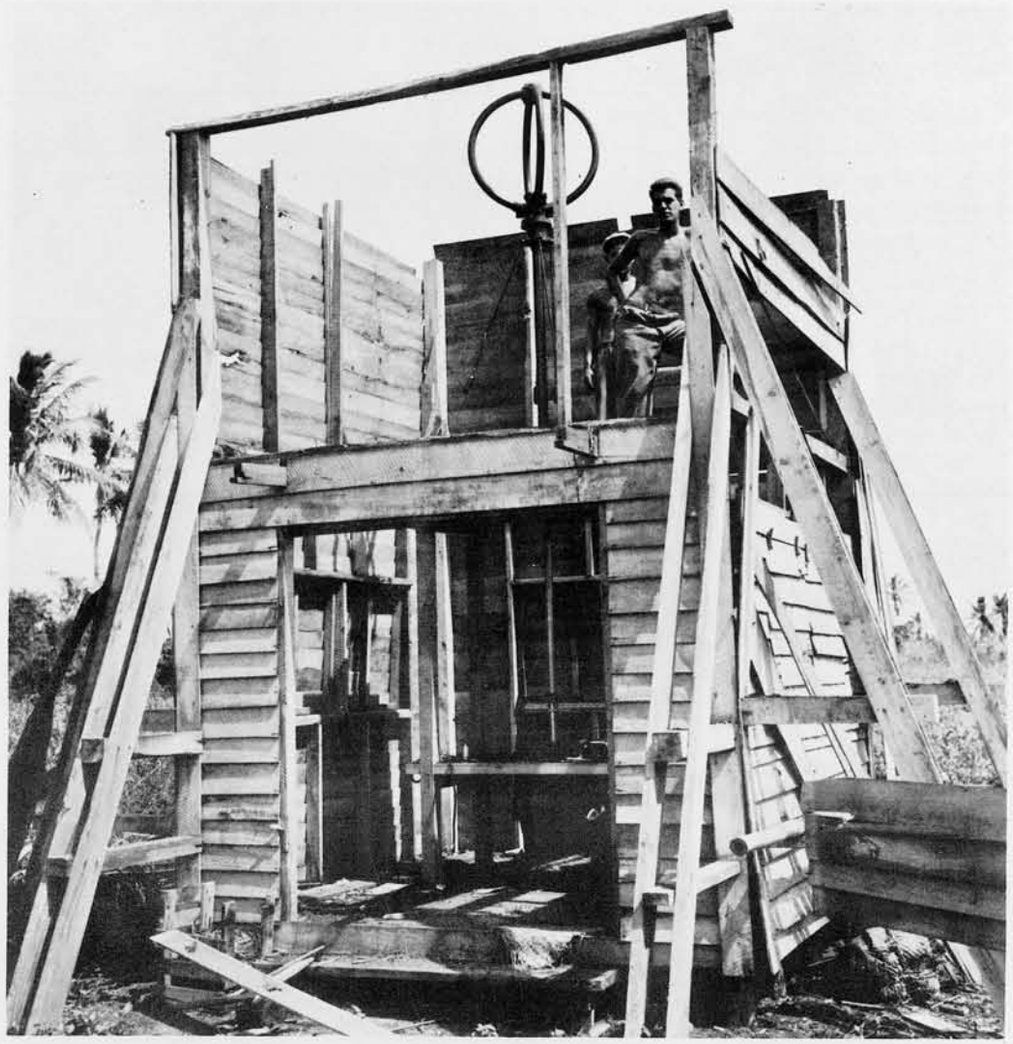
Medium Frequency D.F. tower at Guam. Rotating loop, diameter 3 feet, is similar to type used on naval vessels.

The 12 foot vertical shaft is of metal and its base is set on the operators table. The distance from the floor of the building to the top of the loop is 17 or 18 feet.

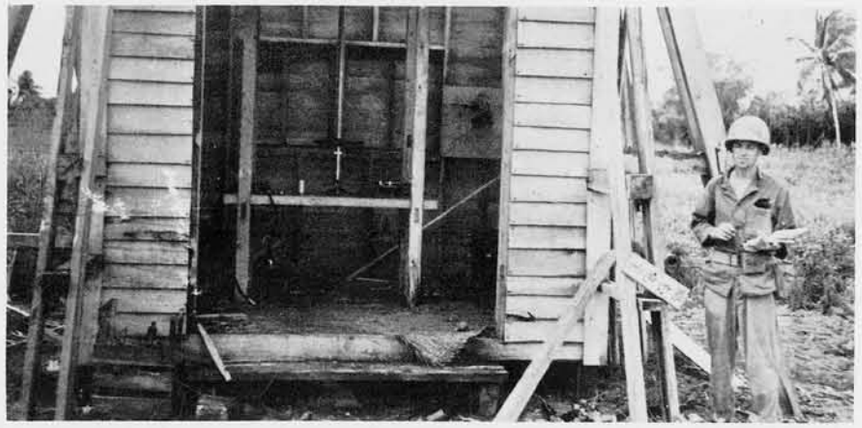
The building is 11'-12' square in plan view (minus buttresses) and was erected in a cleared area.

This building is very apt to be confused with the better known High Frequency D.F. tower, or "Housed Adcock". This type D.F. does not operate on the Adcock principle, however, and its loop is very probably constructed for receiving Medium Frequency signals.

M.F. LOOP TOWER



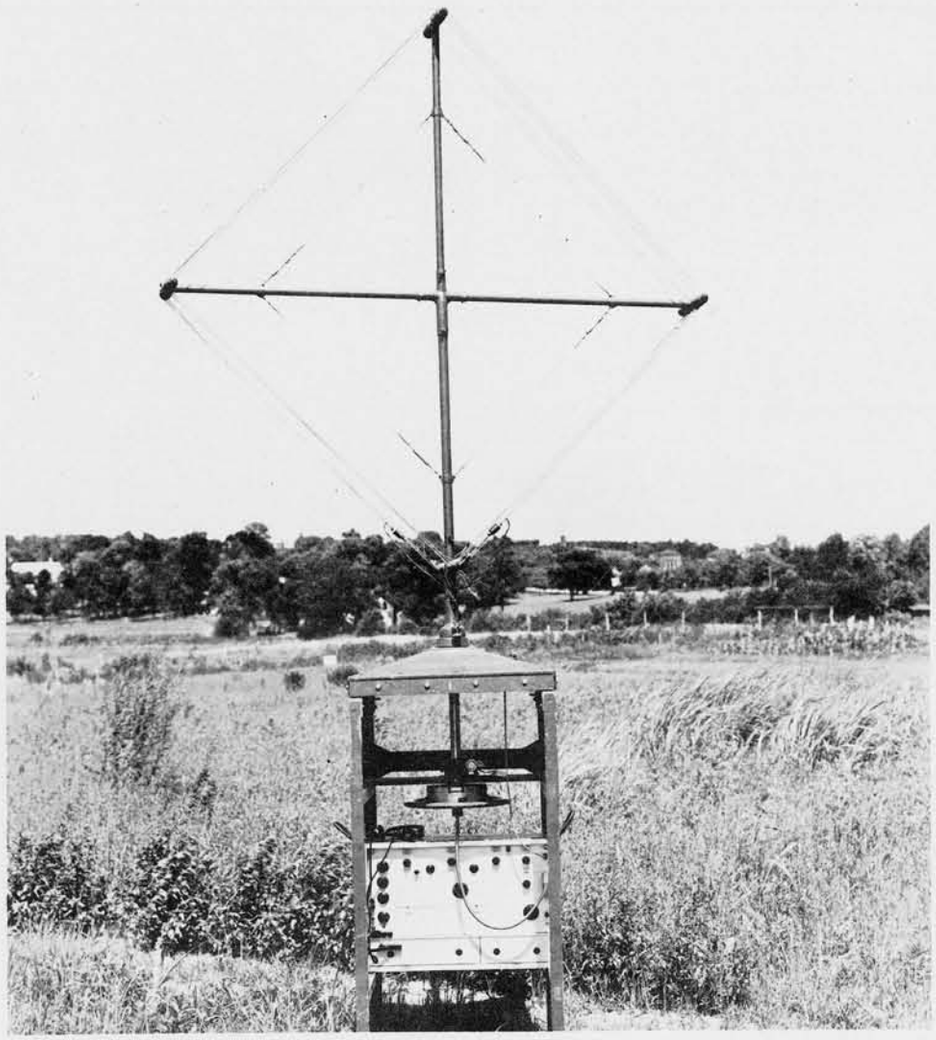
M.F. LOOP TOWER



M.F. LOOP TOWER

DIRECTION FINDER
MEDIUM FREQUENCY (CONT.)

On this page are shown examples of three different types of Japanese Medium Frequency Direction Finders.



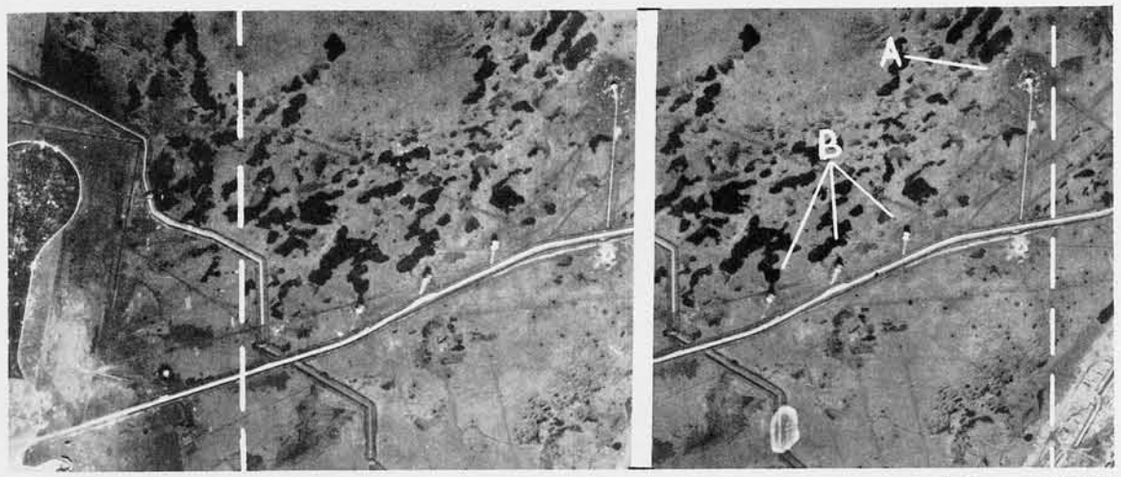
PORTABLE MEDIUM FREQUENCY D. F.

Japanese Army type Portable Medium Frequency D. F. The aerial, which measures 6 feet on the diagonal, rotates through 360 degrees. The installation is complete as shown in above photograph. Dry batteries are included with the receiver.

This D. F. is very similar to U. S. Army types of the year 1930.

The top of the antenna is 12 feet above the ground and the base is 2' x2' x5' high.

The receiver tunes between 100 and 2000 Kcs.



(R.F. - 1/10000)

KURABU CAPE

"A" - MEDIUM FREQUENCY ADCOCK D. F.
"B" - HIGH FREQUENCY D. F. TOWERS

Note that the most striking recognition features of the "Open Adcock" in this vertical compose a pattern made up of central shack, concrete anchors, and circular clearing.

M. F. LOOP

M. F. LOOP TOWER

The above pictures are of a housed Medium Frequency loop D. F. The loop is a Naval type.

CONFIDENTIAL

DIRECTION FINDING

COMBINATIONS

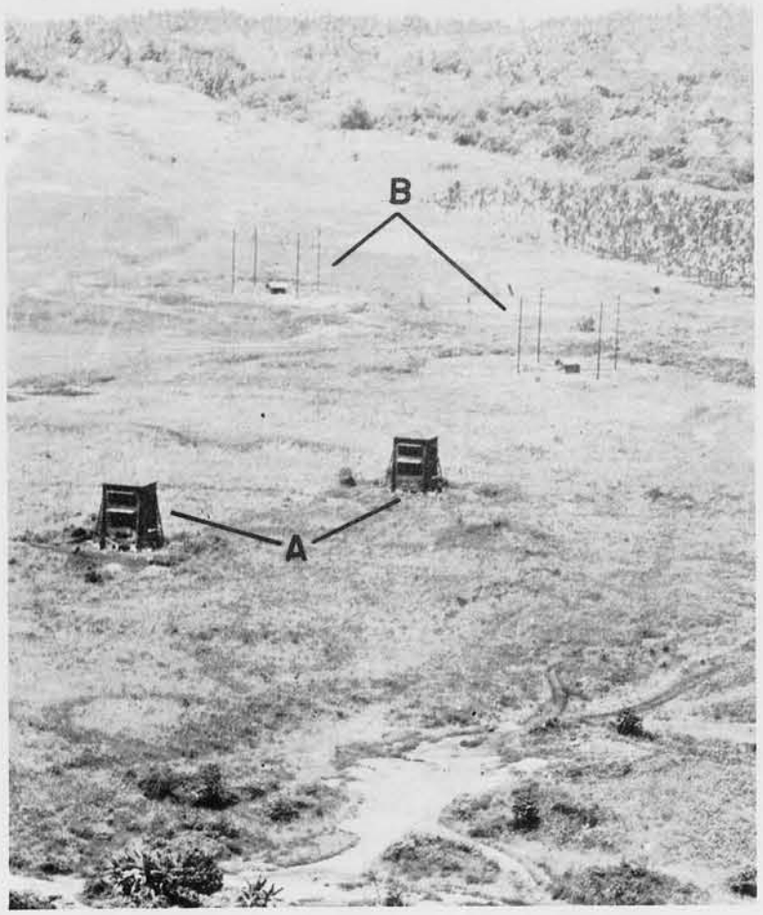
On this page is shown a typical large D.F. station, containing 3 High Frequency towers and 2 Medium Frequency setups.

Most of the identifying characteristics mentioned in the previous pages are visible here. Most Japanese airfields have D.F. stations, and they are frequently found at the end of the runway as is shown in this example.

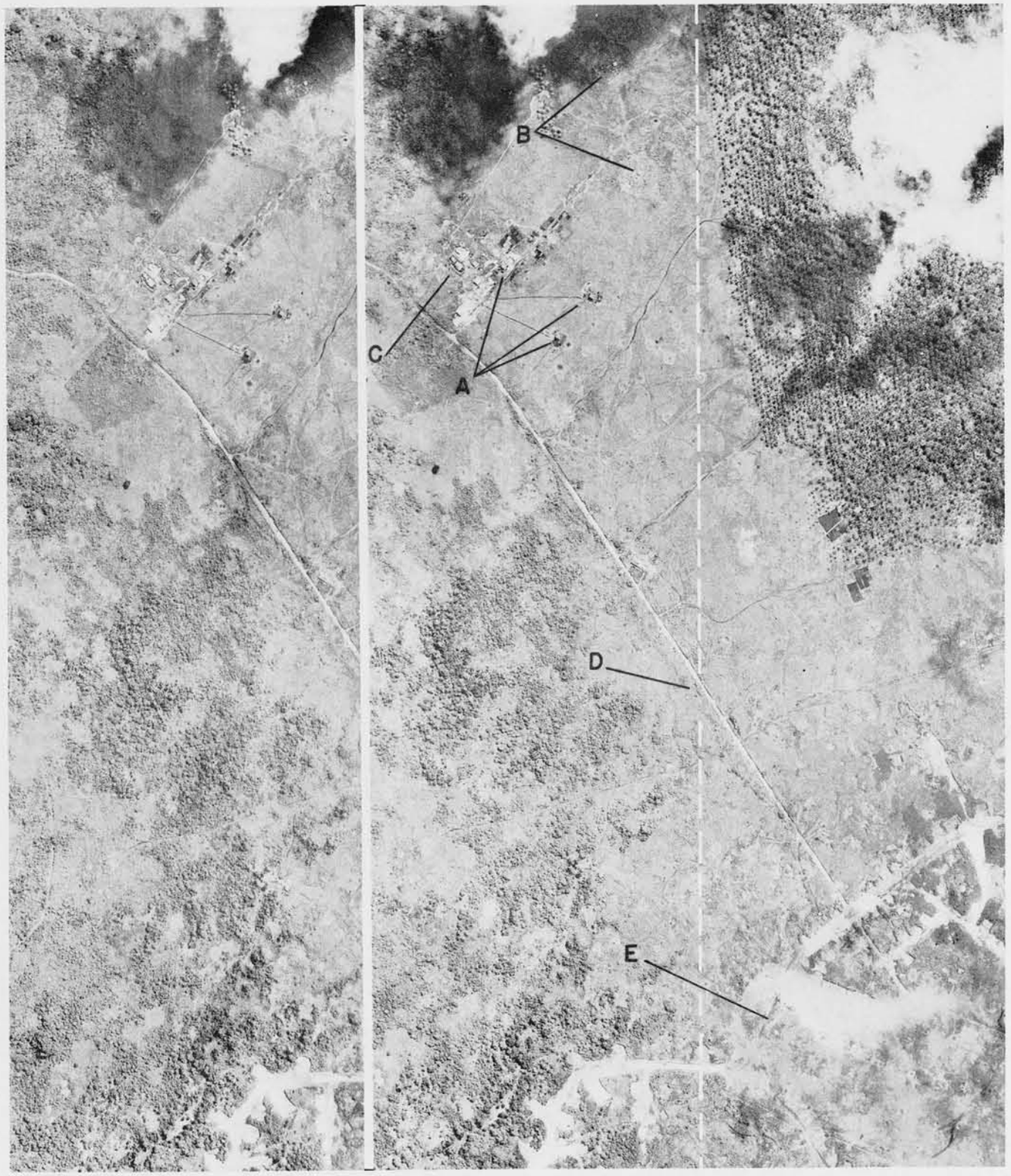
The High Frequency D.F. towers will tune between 3 to 30 megacycles per second. (3000-30000 Kcs.)

The Medium Frequency equipment will tune between 0.1 and 2 megacycles per second. (100-2000 Kcs.)

"A" High Frequency D.F.
"B" Medium Frequency D.F.
"C" D. F. Center
"D" Typical Connecting Road
"E" End of Runway.



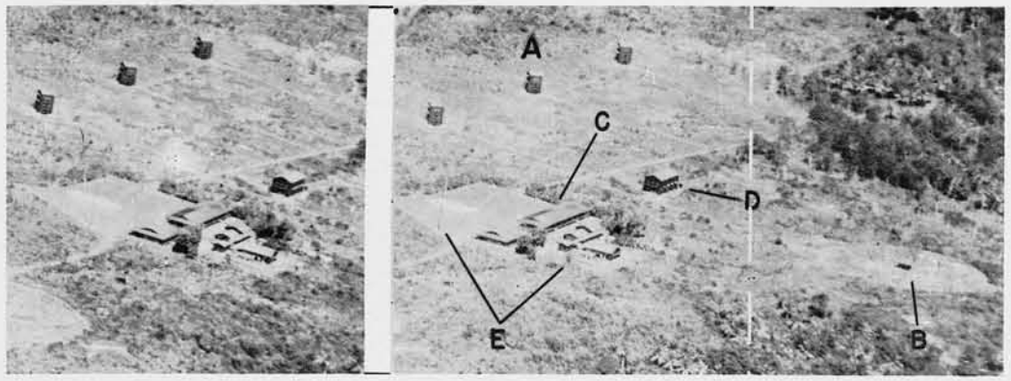
SIMPSON HARBOR, RABAUL



VUNAKANAU, RABAUL, NEW BRITAIN

(R.F. - 1/10200)

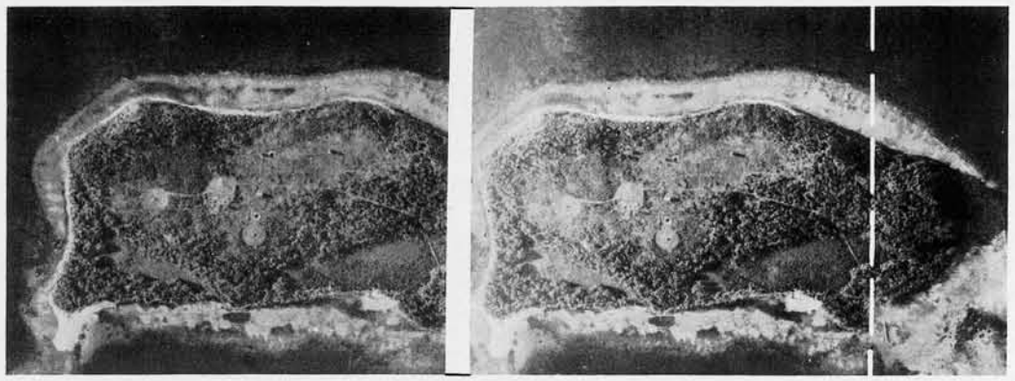
DIRECTION FINDING
COMBINATIONS (CONT.)



TRUK

Oblique stereo view of a typical large D. F. station capable of receiving at various frequencies between 0.1 and 30 megacycles per second.

"A" High Frequency D. F.
"B" Medium Frequency D. F.
"C" D. F. Center
"D" Probable Generator Building
"E" Radio Reporting Station



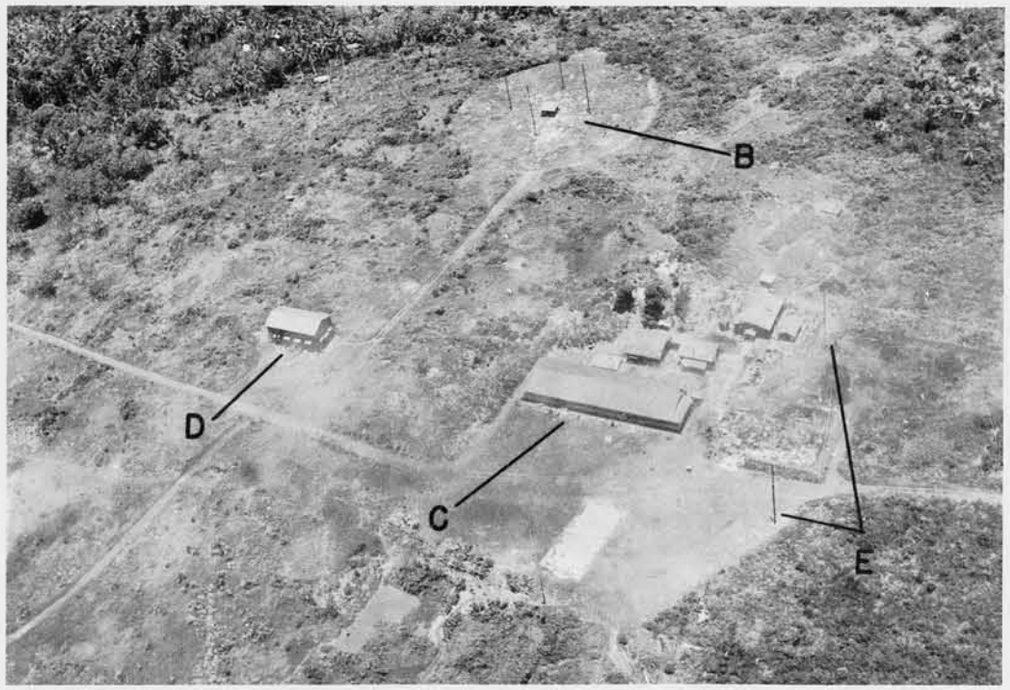
TRUK

(R.F. - 1/19700)

TRUK

Vertical stereo view of Truk D. F. center taken after considerable bomb damage has been administered. Note that identification characteristics such as concrete anchors on Medium Frequency D. F. are visible even at this small scale.

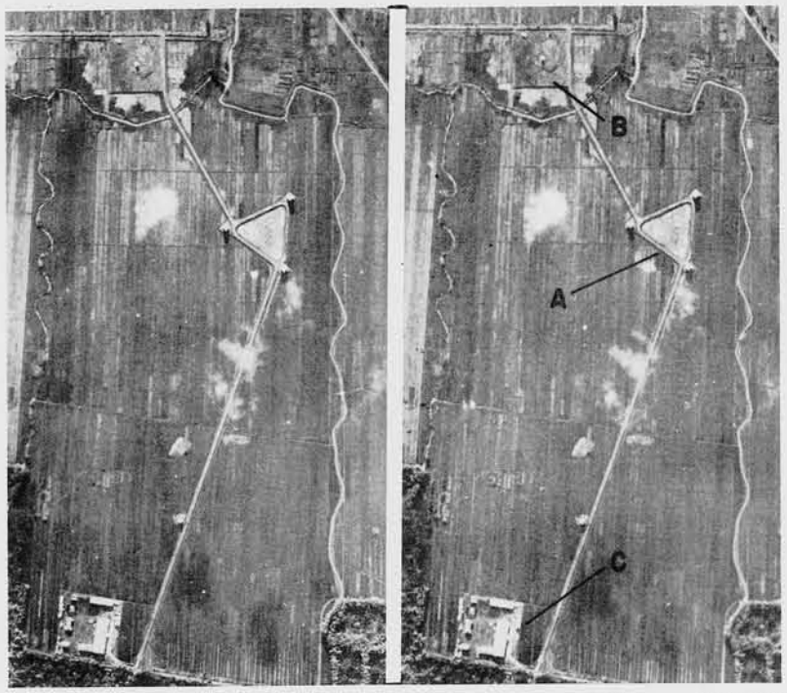
The pattern of roads and paths is an integral part of D. F. station identification. Each installation requires at least one full time operator, hence traffic lanes to all sets are imperative. The High Frequency towers here are of type "4" design.



TRUK

TRUK

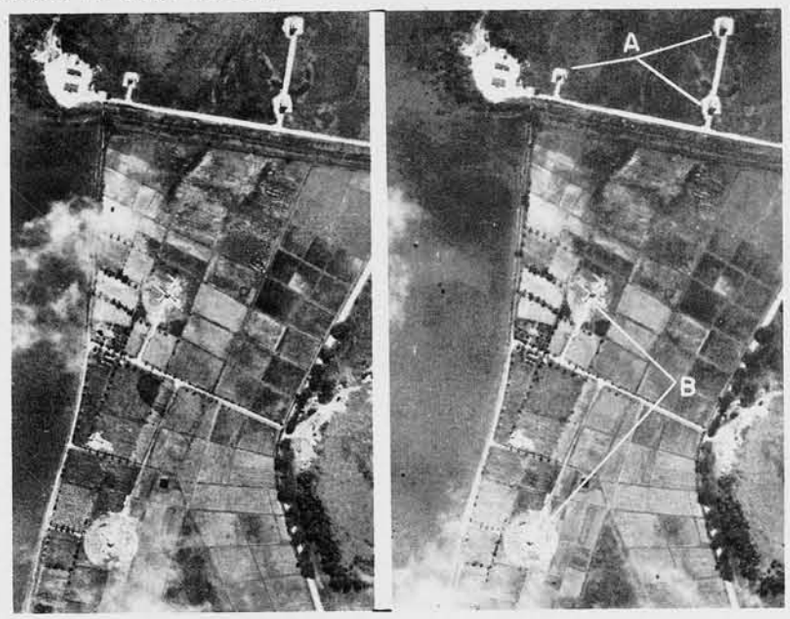
DIRECTION FINDING
COMBINATIONS (CONT.)



(R.F. - 1/10000)

SOERABAJA, JAVA

BELOW: "A" - High Frequency D.F.; "B" - Medium Frequency D.F. Two of the High Frequency buildings appear to be of the type "8" design (see summary). Although this is known to be a standard type, Chaldari is the only example shown in this report.

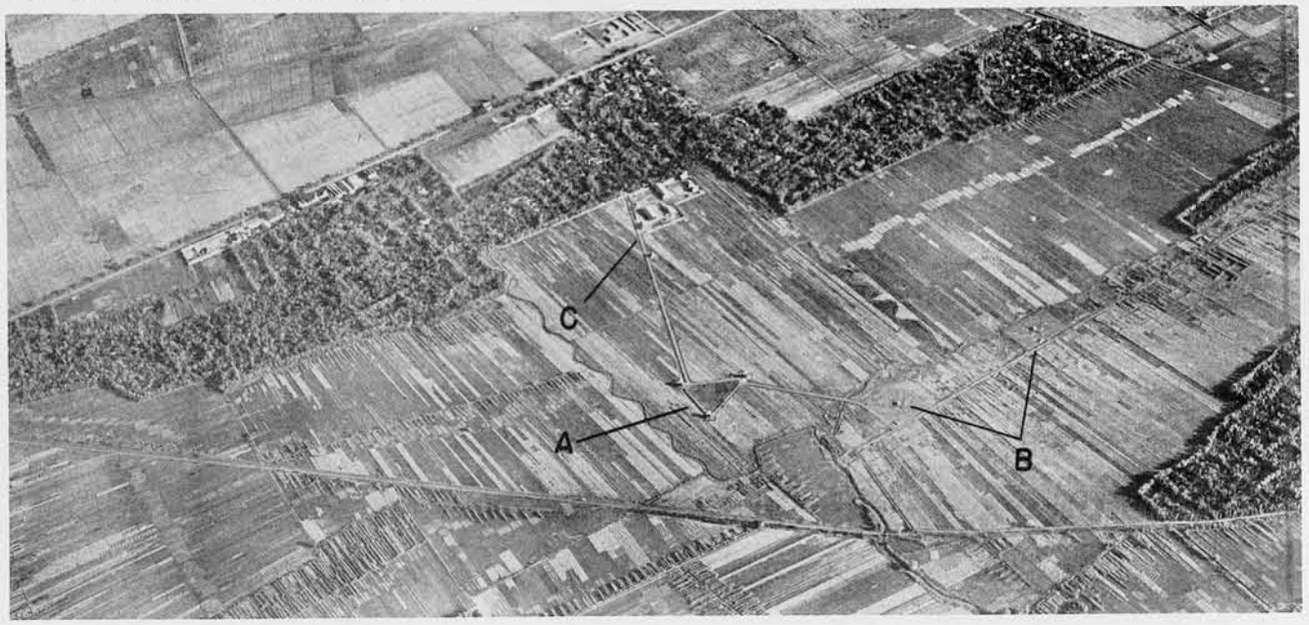


(R.F. - 1/9500)

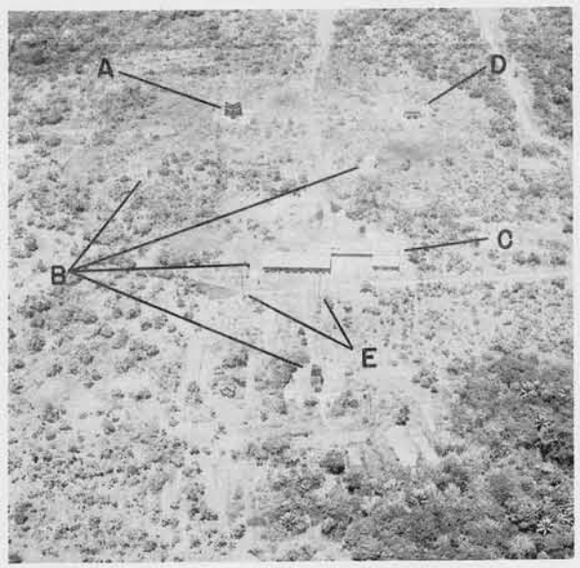
CHALDARI, SO. ANDAMAN IS.

"A" - Three High Frequency D.F.
"B" - Two Medium Frequency D.F.
"C" - D.F. Center

The towers here are arranged in an equilateral triangular pattern with 300 foot sides. The left stereo shows but one of the two existing Medium Frequency installations. The low oblique shows the entire D.F. station and its relationship to the surrounding country. Flooded areas such as rice fields, afford good sites for all types of electronics equipment.

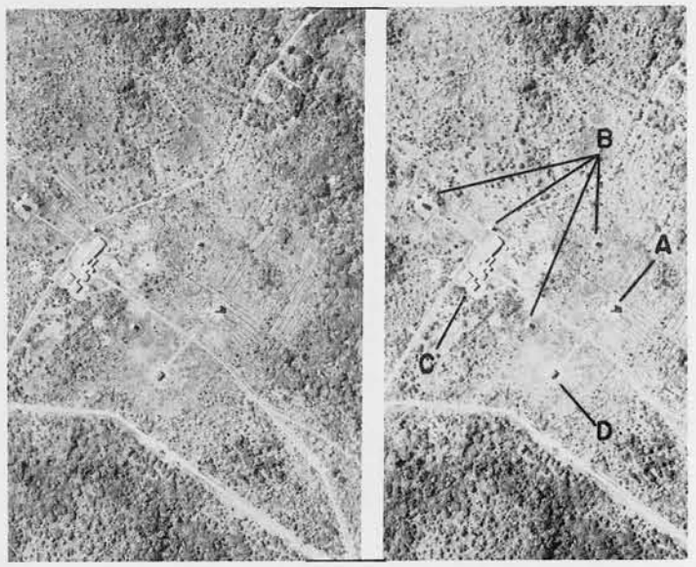


SOERABAJA, JAVA



YAP

"A" - Type "5" D.F. tower (High Frequency)
"B" - Towers, presumed to enclose loop type Medium Frequency D.F.

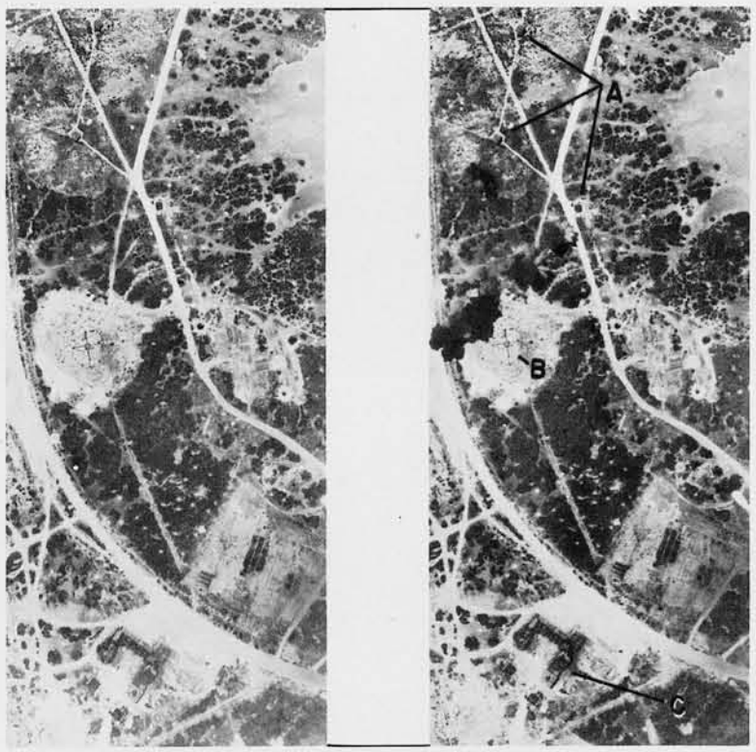


(R.F. - 1/9000)

YAP

"C" - D.F. Center
"D" - Probable Generator Building
"E" - Masts of Radio Reporting Station

DIRECTION FINDING
COMBINATIONS (CONT.)



WAKE

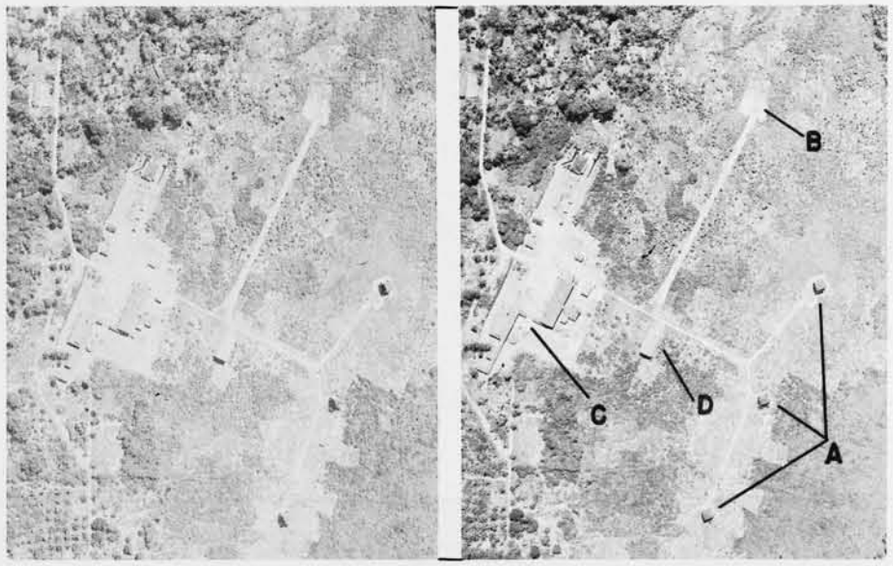
(R.F. - 1/7500)

LEFT:
D.F. center on Wake
"A" - Three type "I" High Frequency towers
"B" - One Medium Frequency DF
"C" - Attu type Radar on roof of former U.S. Bachelor Officers Quarters.

Radar is often found in conjunction with D.F. Stations.

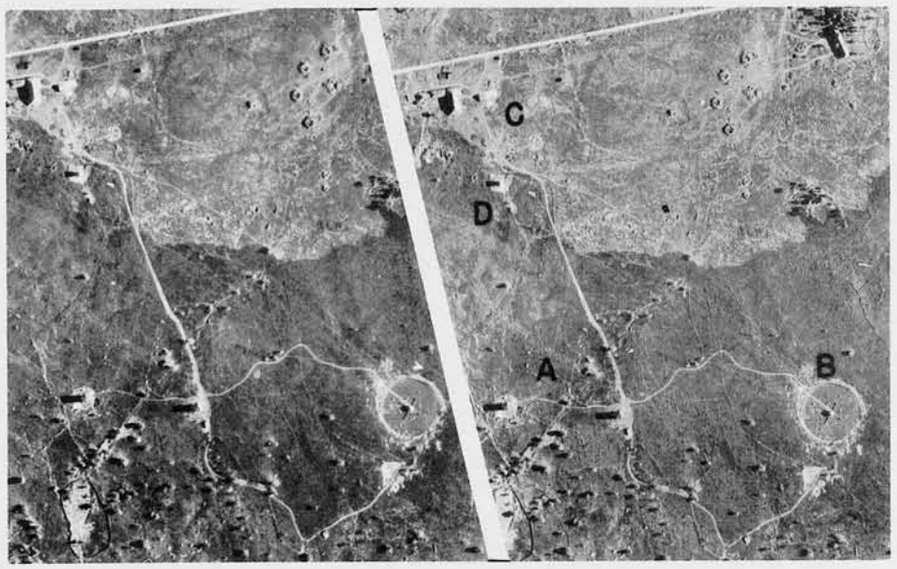
Note path and road connections to all D.F. installations

D.F. Center is probably across road to the right of Medium Frequency set.



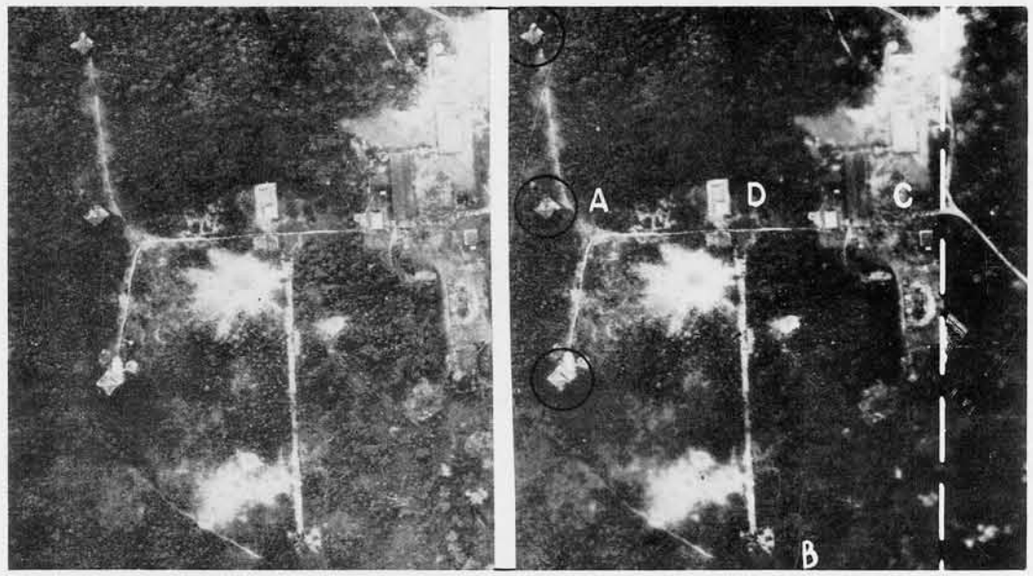
PALAU

(R.F. - 1/5000)



KOEPANG, TIMOR

"A" - TWO HIGH FREQUENCY D.F. TOWERS "B" - ONE MEDIUM FREQUENCY D.F.
"C" - D.F. CENTER WITH RADIO REPORTING STATION (MEDIUM FREQUENCY)
"D" - POSSIBLE HIGH FREQUENCY D.F. TOWER (NEWLY ERECTED - THIS DESIGN HAS NOT BEEN SEEN ELSEWHERE)



PALAU

(R.F. - 1/4000)

"A" - Three type "5" High Frequency D.F. towers
"B" - Site probably originally planned for Medium Frequency D.F.
"C" - D.F. Center
"D" - Probable Generator Building

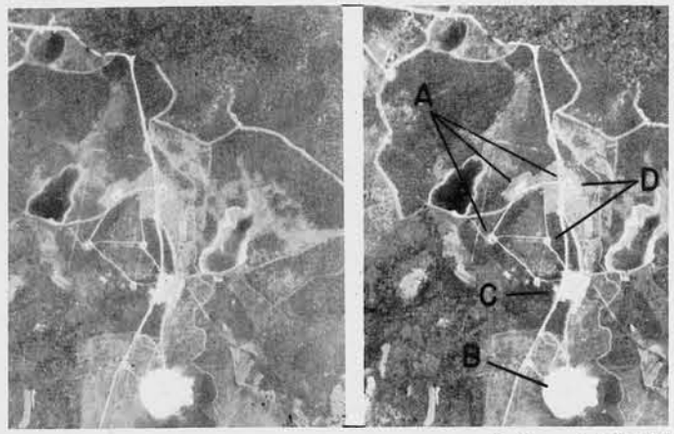
The above two stereograms of the Palau D.F. station were taken several months apart. The lower one shows considerable bomb damage and some new construction. Apparently the Medium Frequency project was abandoned.

DIRECTION FINDING

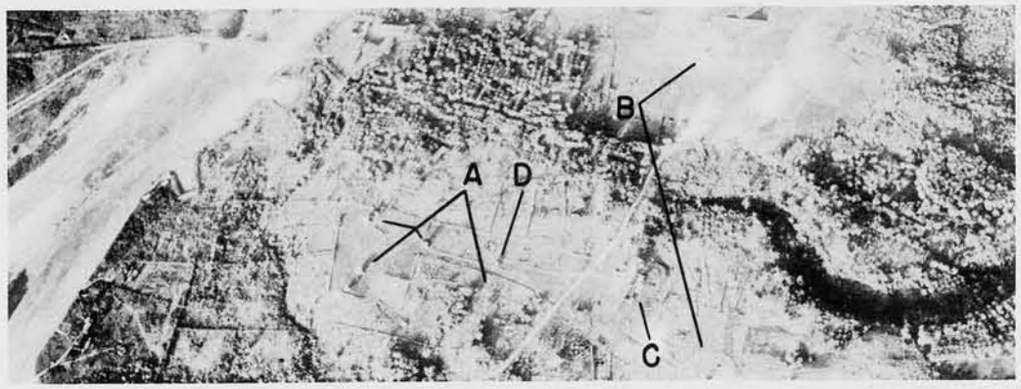
COMBINATIONS (CONT.)

This is the first conclusive proof that the Japanese style of D.F., as standardized through the Pacific islands, is also used on the homeland in the same manner.

"A" - Three High Frequency D.F. towers
"B" - Medium Frequency D.F.
"C" - D.F. Center
"D" - Probable old type Medium Frequency D.F. such as type "8"

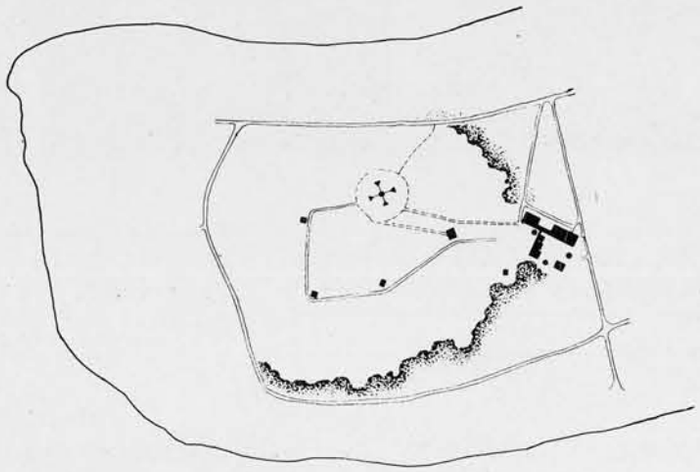


SASEBO , JAPAN (R.F. - 1/16170)

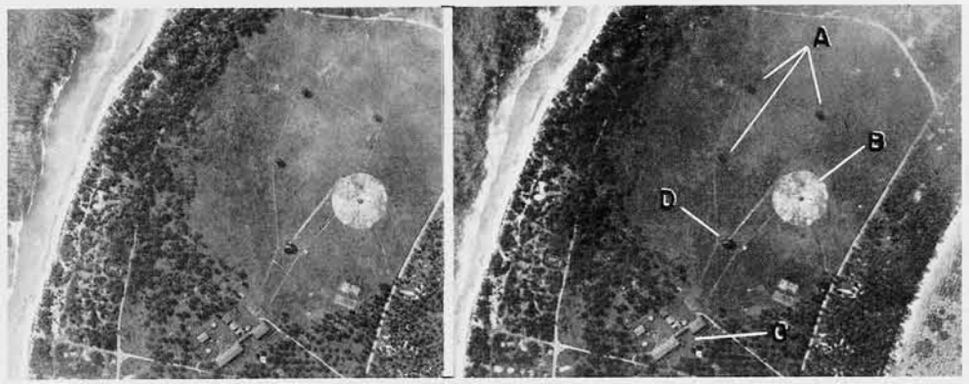


SABANG, SUMATRA

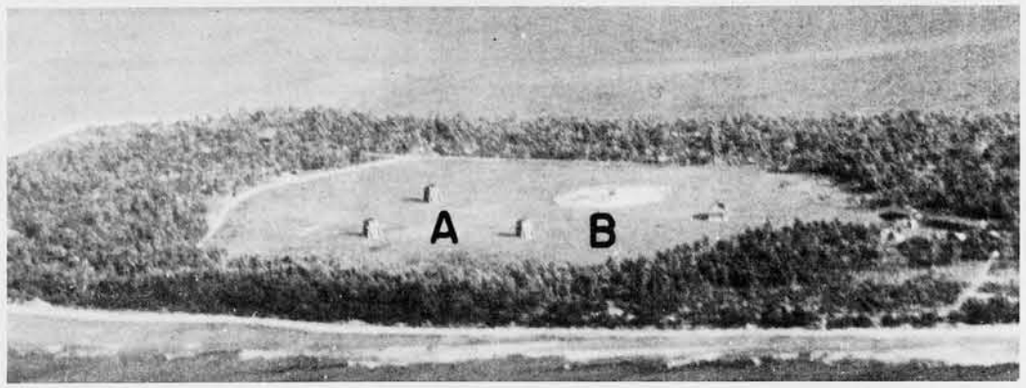
"A" - Three High Frequency D.F. towers
"B" - Two Medium Frequency D.F.
"C" - D.F. Center
"D" - One Probable High or Very High Frequency tower (low type)



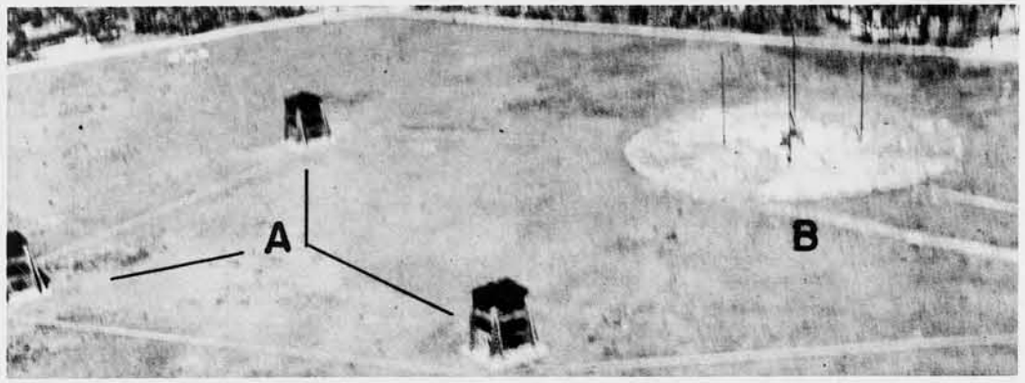
KWAJALEIN



KWAJALEIN (R.F. - 1/10000)



KWAJALEIN



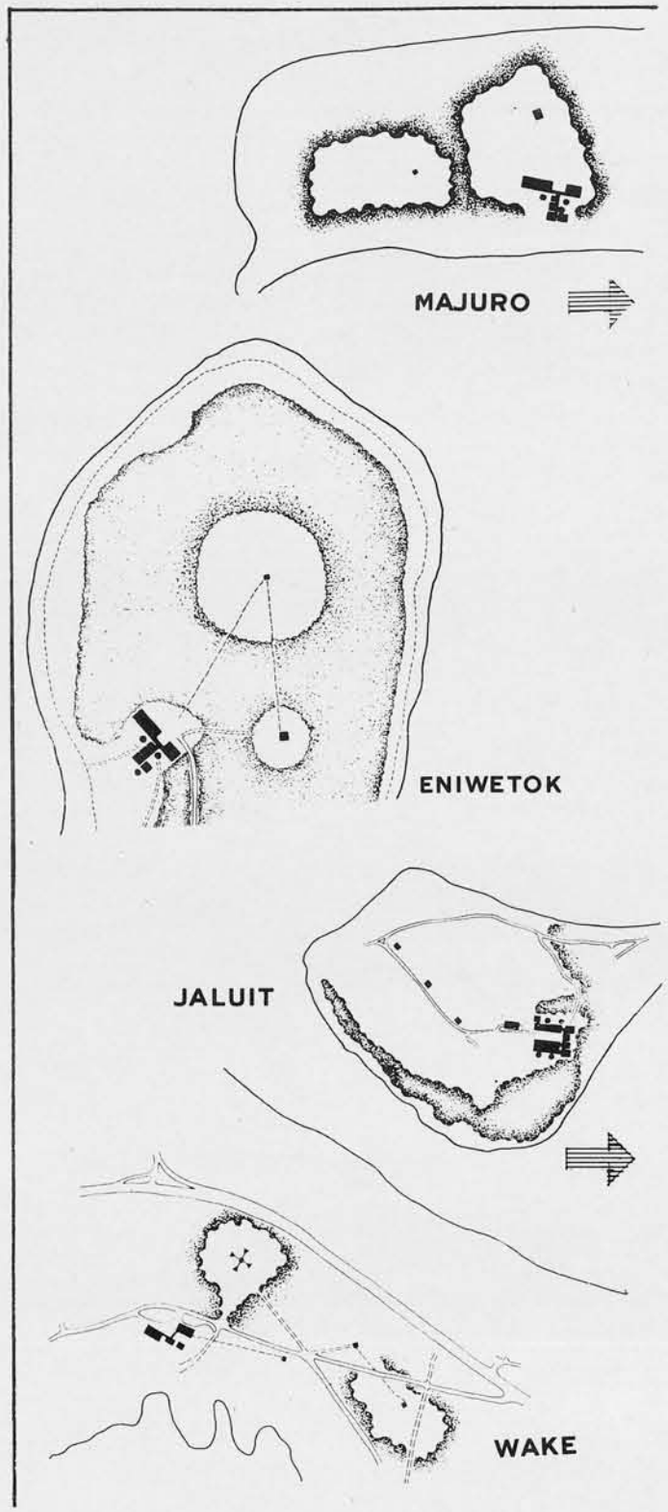
KWAJALEIN

"A" - Three type "5" High Frequency D.F. towers.
"B" - One Medium Frequency D.F.
"C" - D.F. Center
"D" - Probable Generator Building

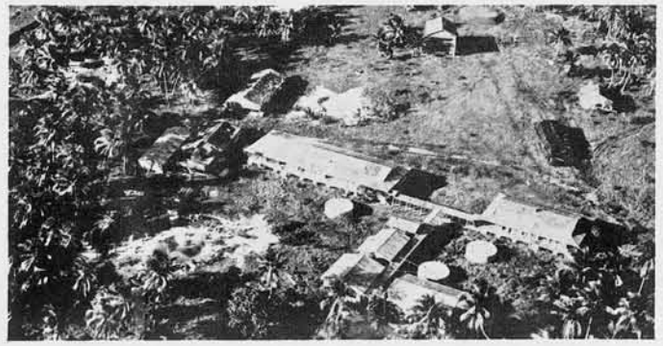
One of the first Japanese D.F. stations observed was at Kwajalein.

Note constant orientation of all D.F. installations with respect to north.

DIRECTION FINDING
CENTERS



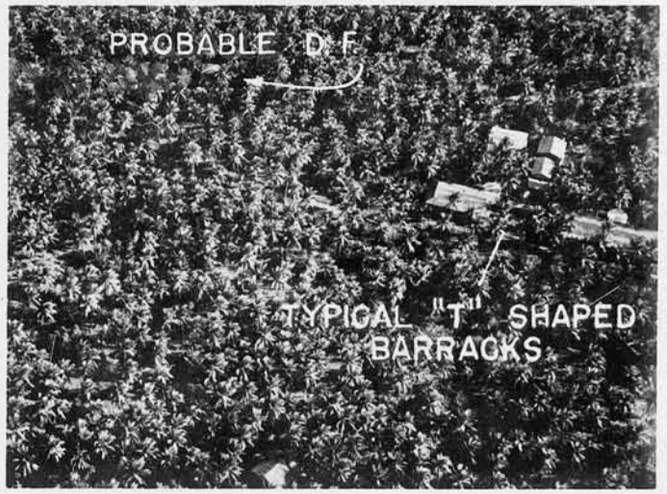
Drawings of four D. F. stations showing the similarity in pattern and location of D. F. centers.



DARRITT, MAJURO, MARSHALLS

Japanese Direction Finder Stations often include a building group which is used for communications, administration and living facilities. Such a building group is here called a "D. F. Center".

The D. F. Center is easily recognizable by its pattern and location. In plan it assumes "T", "H", or "U" shape. It is usually composed of prefabricated wooden one story units connected by narrow covered passageways.



UTIRIK

The largest elements of the building group are likely to be barracks or offices. The radio transmitter is often located at one end of the barracks building. This site should be cleared.

JALUIT, MARSHALLS

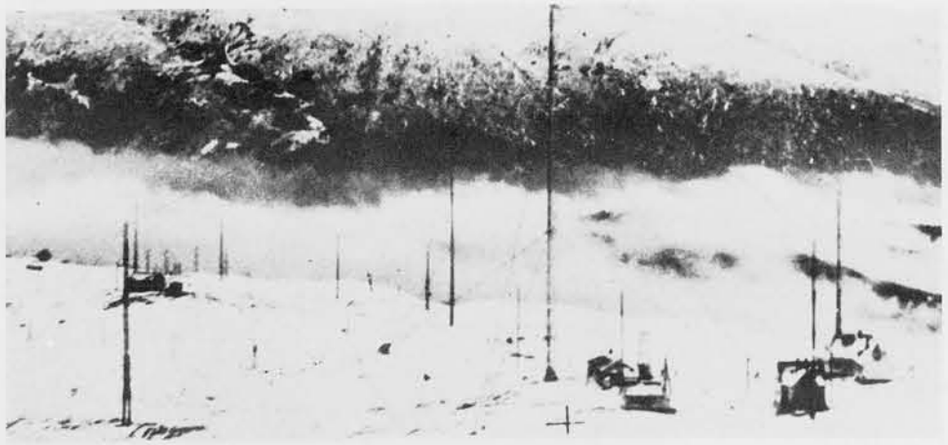
"A" - MESS HALL OR BARRACKS
"B" - LATRINE
"C" - WASH HOUSE
"D" - GALLEY
"E" - WATER STORAGE
"F" - OFFICES
"G" - BARRACKS
"H" - TRANSMITTING EQUIPMENT
"J" - UNIDENTIFIED (PROBABLY FOR GENERATING POWER)
"K" - MASTS FOR RADIO REPORTING STATION

VUNAKANAU, RABAUL, NEW BRITAIN

"A" - D. F. Center
"B" - High Frequency D. F. Tower
"C" - Mast for Radio Reporting Station

DIRECTION FINDING

GERMAN



BELLINI - TOSI

The Bellini-Tosi D.F. consists of a tall central mast surrounded by four short masts which support aerials slung from the central mast. Since these feeds are above ground, no cross pattern is visible. The hut is slightly off center due to position of central mast. This is a loop type D.F.

MEDIUM FREQUENCY ADCOCK

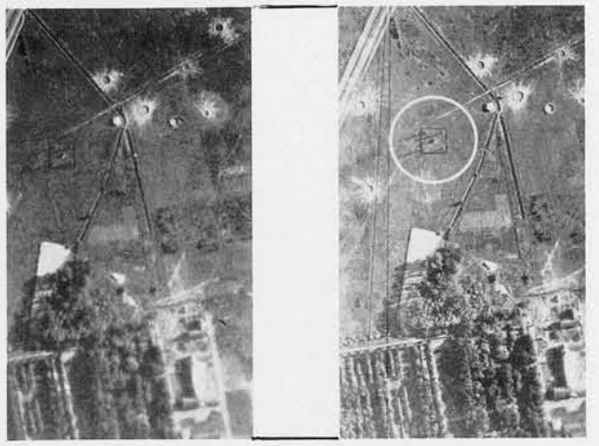
Identifying characteristics of the German Adcock are clearly visible in this low oblique: Four masts in square, central hut, and square fence enclosure. Mast on hut is a central sensing antenna and is frequently visible. White scar leading from outside fence is buried power cable.

Note that the mast is a more elaborate design than on Japanese Adcocks.

There are two types of Direction Finders used by the Germans, the Adcock and the Bellini-Tosi. The Adcock type is the more generally used.

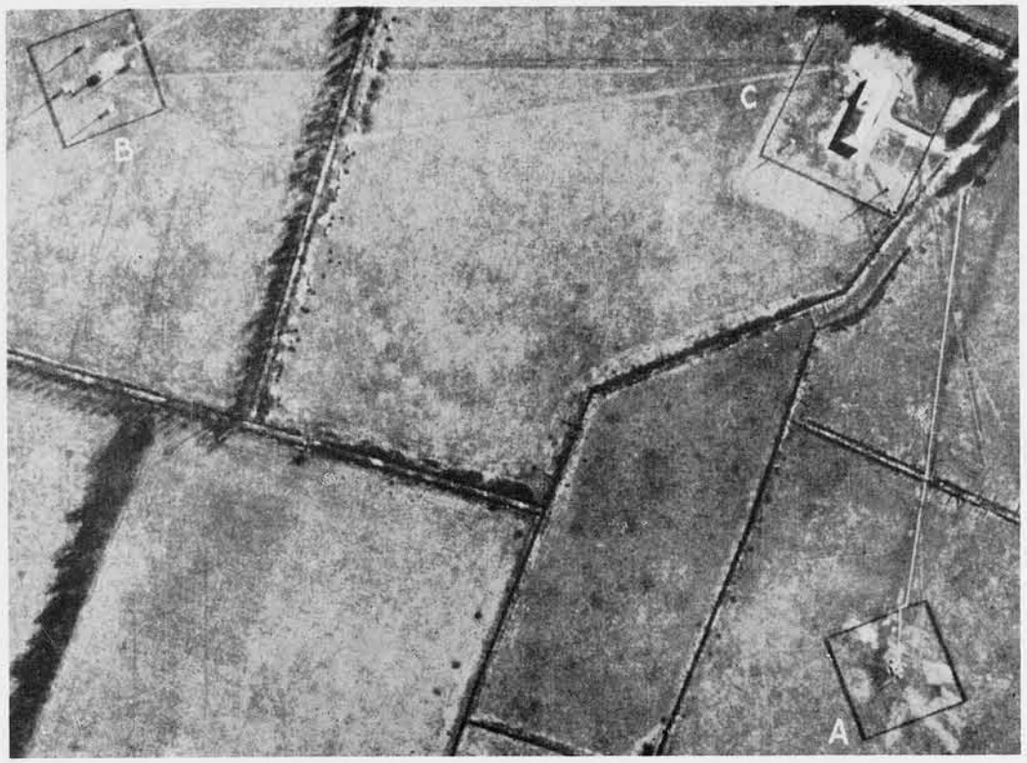
RIGHT: German Medium Frequency Adcock D.F. resembles the Japanese type, except for the well standardized use of a square fence (or wall) enclosure around the installation. This is strongly visible in aerial photographs, as is the circular clearing around the Japanese "Open Adcock".

The buried feeds create cross shaped ground scars of equal length and with arms usually lying in N.,E.,S., and W. directions.



GERMANY (R.F. - 1/10000)

MEDIUM FREQUENCY ADCOCK



HIGH AND MEDIUM FREQUENCY ADCOCKS VILLERS, FRANCE

"A" - German High Frequency Adcock. Diagonal spacing between unipoles is about 30 feet.

"B" - German Medium Frequency Adcock. Diagonal spacing between unipoles is about 100 feet. note shadow of central sensing antenna, which is seldom visible in Japanese installations.

"C" - Headquarters building including radio reporting station. Scars leading out from this building are buried power lines.

DIRECTION FINDING
GERMAN (CONT.)

German Pylon Stations are used in connection with Aircraft Control. They consist of a Benito D.F. and a Benito Transmitter (do not confuse with Benito Navigational Aid) and a plotting hut.

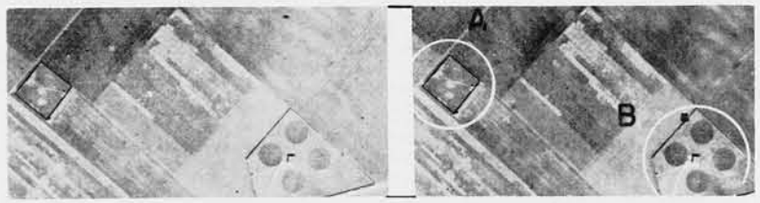
They function as follows: The rotating Adcock type D.F. (mounted on the pylon) receives signals from the aircraft at 38.4-40.4 mcs. Information on range and bearing thus received goes to the plotting hut. Instructions emanating from here are relayed to the transmitter hut which sends same back to the aircraft at 40.4-42.3 mcs.

The Pylon is about 65 feet high and the transmitter mast is about 90 feet high.

The typical Medium Range Benito station contains five D.F. pylons and five transmitters, all operating on slightly different frequencies for simultaneous control of five different aircraft.

There is a "short range" Benito set (not shown here) which is found on G.C.I. sites. It is similar but much smaller, the pylon and transmitter masts being but 25 feet high.

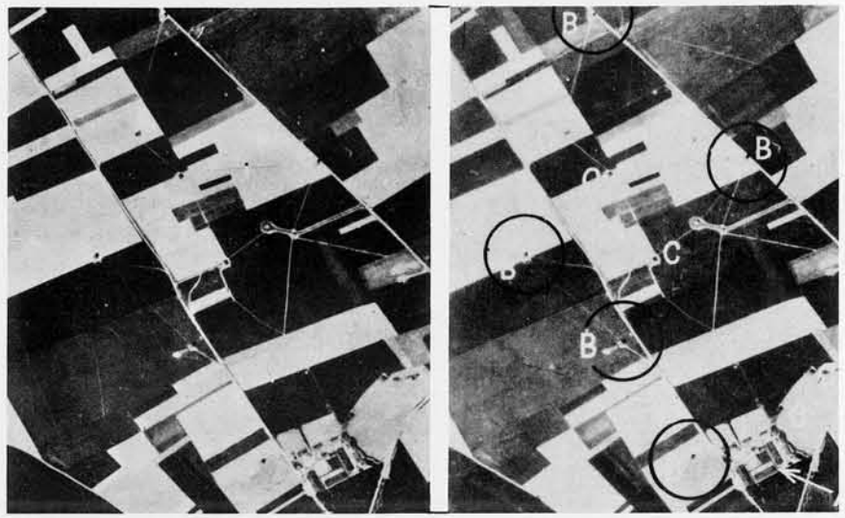
PYLON STATIONS A. "T" hut, B. Pylons, C. Transmitter huts.



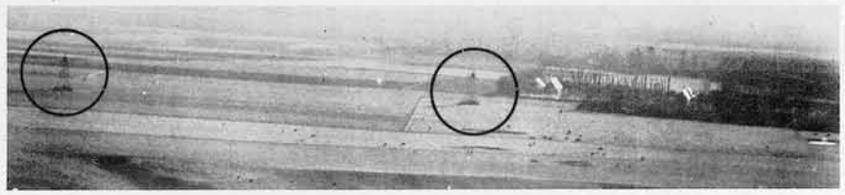
(R.F. - 1/4500)

ADCOCK D.F.'S

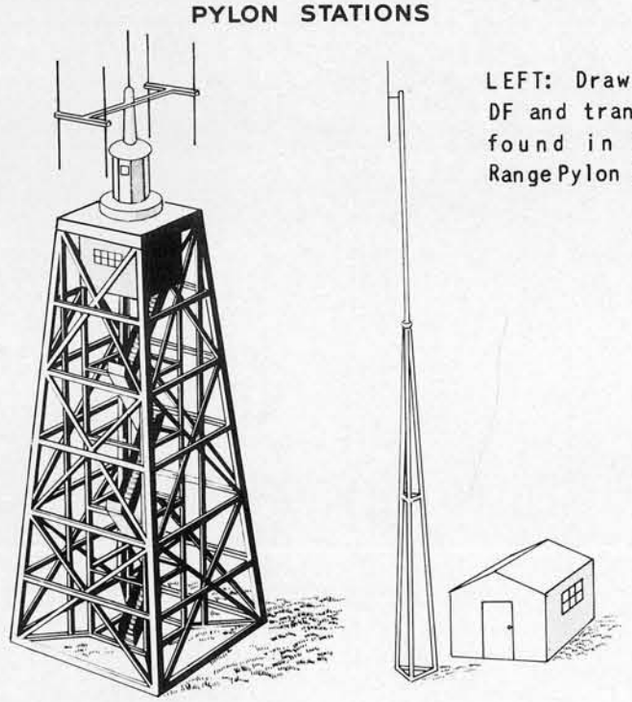
Left: "A" - Medium Frequency, "B" - High Frequency. Both of these installations are of the fixed Adcock type. Note that High Frequency collectors are in the open rather than housed, as in Japanese types.



PYLON STATIONS A. "T" hut, B. Pylons, C. Transmitter huts.



PYLON STATIONS



LEFT: Drawings of DF and transmitter found in Medium Range Pylon Stations

MEDIUM RANGE BENITO D.F. RECEIVER PYLON

MEDIUM RANGE BENITO TRANSMITTER HUT AND MAST

SECTION-4

4.01 — 4.99

NAVIGATIONAL AIDS

NAVIGATIONAL AIDS
SUMMARY

Navigational aids, which are TRANSMITTERS of radio beams, are dealt with in this section. Included in this category are terms such as radio beacons, beam transmitters, navigational beams, and radio stations. (Direction Finders, which are also used as aids to navigation are included only under Section 3.)

PURPOSES

There are two primary purposes for navigational aids:

1. To guide ships or aircraft home to their base.
2. To guide aircraft to a bombing target.

INTERPRETATION

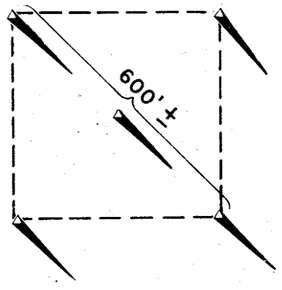
Navigational aids are difficult to interpret from aerial photos, primarily because of the large variety of possible shapes, patterns and sizes such installations may assume.

Although the Germans have standardized certain very high frequency navigational aid equipment (such as the Knickebein), Japanese installations that have been positively identified do not appear to be standardized as to type.

JAPANESE NAVIGATIONAL AIDS

1. RADIO RANGE STATIONS FOR AIRCRAFT

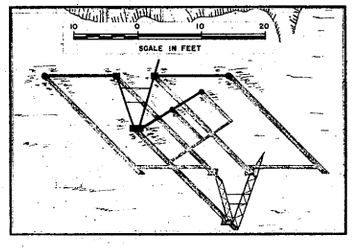
These stations operate normally at between 100 and 300 Kcs. and require no equipment in the plane other than the usual radio receiver. From them one or several beams may be directed to any point of the compass. Reliable distance range would be from 200 to 400 miles.



5 MASTS 200' ± HIGH

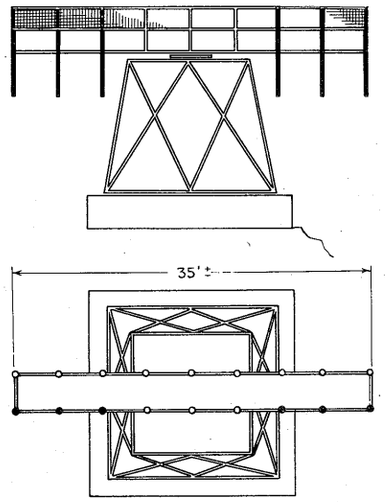
2. KISKA NAVIGATIONAL AID FOR SHIPS

This installation, the only one of its kind found to date, is apparently a makeshift arrangement and is of poor design. It operates at 60 to 70 Mcs. and has effective distance range of approximately 100 miles.



3. CHICHI JIMA NAVIGATIONAL AID FOR SHIPS

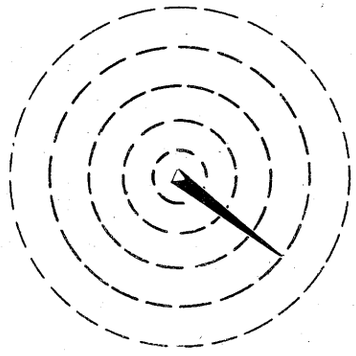
Recently a suspected navigational aid which commands the entrance to the harbour of Chichi Jima, Bonins, has been photographed. If a navigational aid, this installation is probably used for guiding ships at sea.



Note: No other types of Japanese Navigational Aids are known to have been identified from photos (except for communications stations) up to date of publication.

SINGLE RADIATING LATTICE MAST FOR AIRCRAFT

A single radiating mast may serve as an air navigational aid having no directional capacities in itself. Such an installation may send out a beam covering a circular pattern with the mast in the center.



When an aircraft comes within this area of signals, D.F. equipment in the plane itself will home the plane.

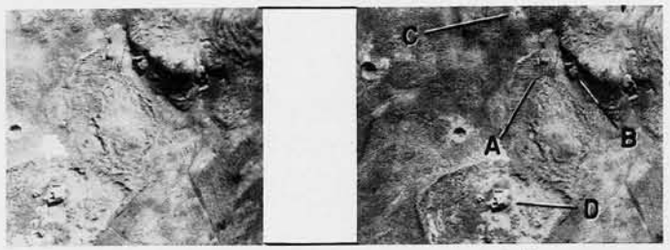
Note: Any single lattice mast is suspected of being an air navigational aid, even though it may not function in the manner shown above.

SIGNALS

Final identification of a Navigational Aid will best be accomplished by checking carefully against any signals that may have been recorded from the area being interpreted-

NAVIGATIONAL AIDS

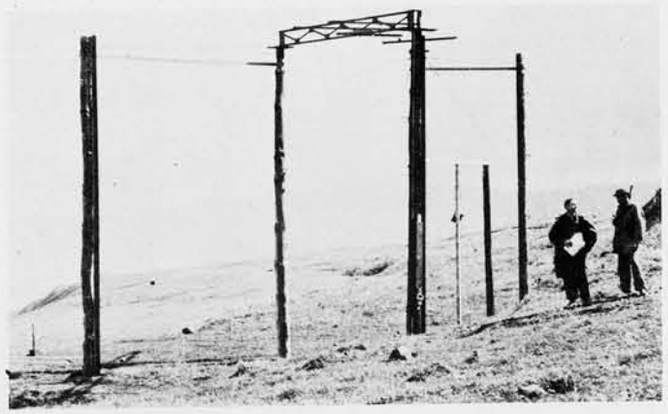
JAPANESE



(R.F. - 1/5200)

KISKA

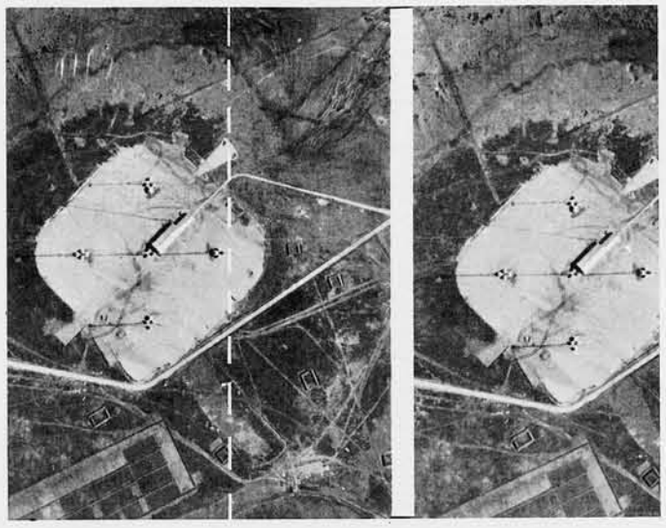
"A" - NAVIGATIONAL AID
"B" - DUGOUT FOR GENERATOR
"C" - MONITOR RECEIVER
"D" - PERSONNEL HUT



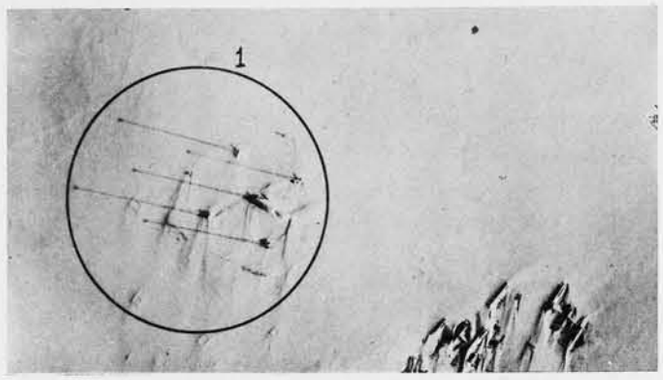
KISKA

The above radio navigational aid, found at South Head, Kiska, was the first Japanese aid captured in this war. Its purpose was to guide ships at sea. This installation is of makeshift nature and is not an efficient electronics device. It is unlikely that the design will be found again. The reflectors are 29 feet long and are set 20 feet above ground level. It operates at a frequency of 70 mcs. Code beam switching, similar in principal to "A and N" is used.

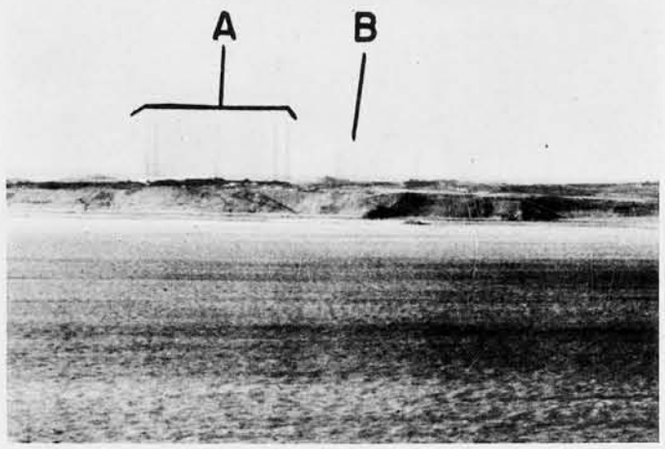
RIGHT: Five mast Radio Range Station at Kurabu Cape, Paramushiro, is very similar to peace time "beam" stations for aircraft. The masts are about 200 feet high and the circular forms at top indicate that they are "top-loading" radiators. The diagonal distance between masts is approximately 600 feet which would indicate frequencies between 200 and 400 Kcs. Radio Range Station.



KURABU CAPE

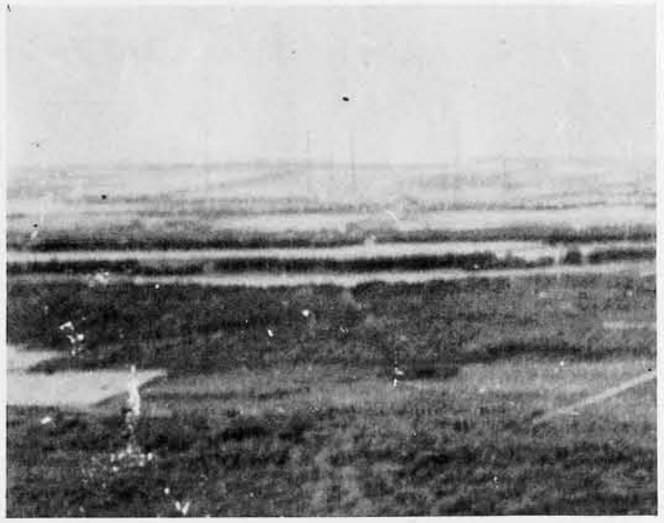


KURABU CAPE



KURABU CAPE

"A" - RADIO RANGE STATION
"B" - MEDIUM FREQUENCY COMMUNICATIONS STATION



TINIAN, MARIANAS

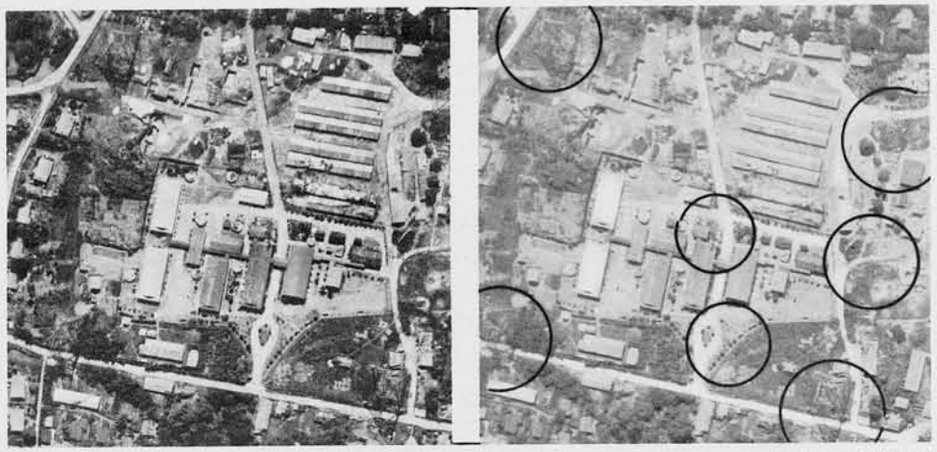
TINIAN

ABOVE: Two views are shown of another Japanese Radio Range Station at Tinian. This pattern of five masts with a diagonal distance of 600 feet is characteristic of Radio Range Stations. This is an air navigational aid.

The advantages of low frequency navigational aids of this type are as follows:

(a) Long range and reliable
(b) No special equipment necessary in plane. Usual radio receiver will act in place of direction finders etc.
(c) May exist from peacetime construction period.

Frequency is usually between 200 and 400 Kcs.



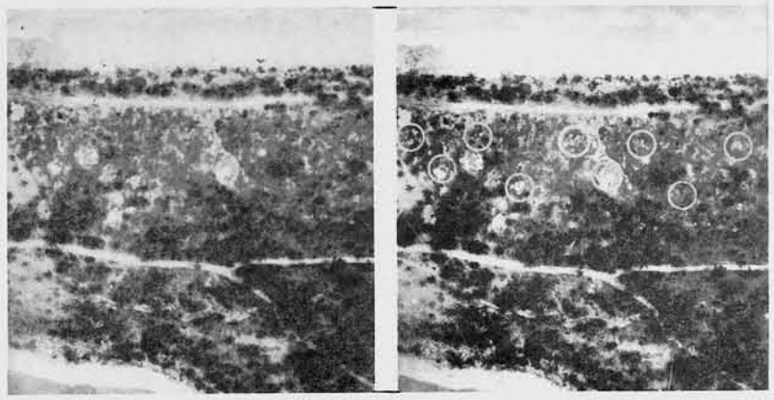
(R.F. - 1/4800)

PALAU

Pre-war Low Frequency Radio Station at Palau which may have facilities for sending a navigational beam for aircraft. The lattice masts are 300 feet high and set in a square pattern with a diagonal distance of 1000 feet.

The stick masts, added recently, are about 100 feet high and are undoubtedly for communications.

There is apparently a small lattice mast in the center of the square pattern of large masts, which would lend support to the thesis that the station could be used for sending a navigational beam.

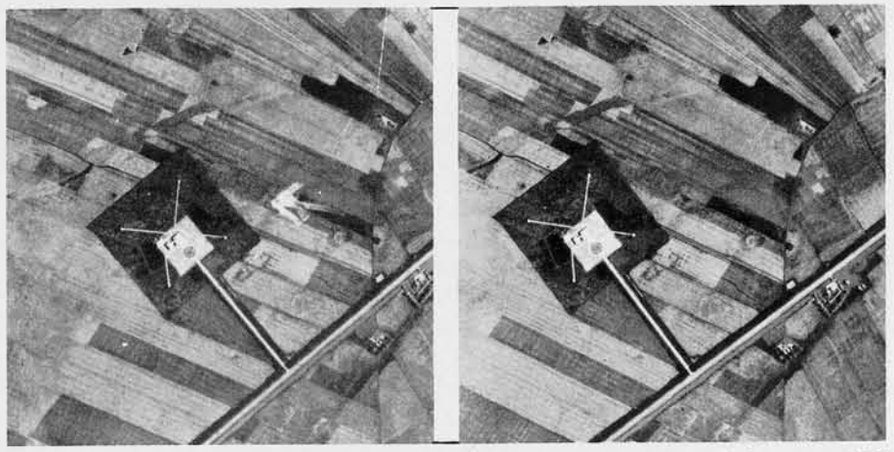


MILLE, MARSHALLS

ABOVE: Stereogram of possible Air Navigational Aid at Mille showing all nine spliced wood stick masts.

A similar mast pattern is also used for directional transmitting and receiving of communications, and it is possible that this may be an intercept station.

A three mast medium frequency communications station is just off the picture to the lower left.

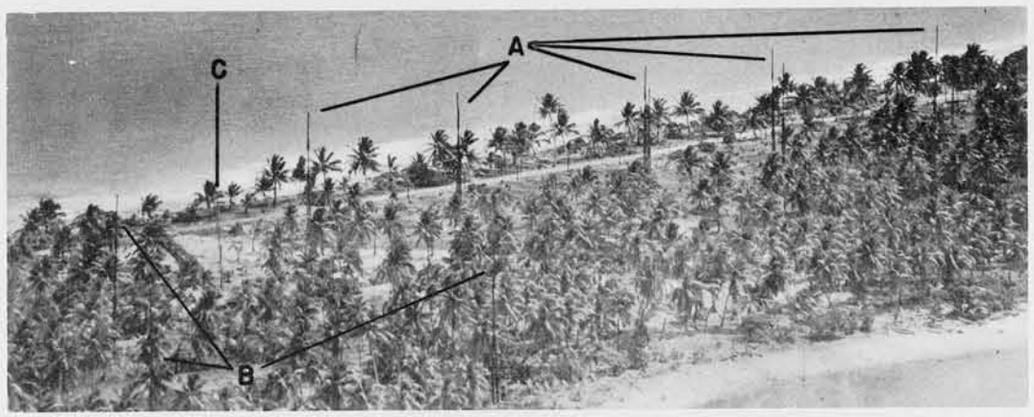


(R.F. - 1/14000)

BANKOK, THAILAND

This installation at Bankok is unusual in that, excepting for size, it looks like a D. F.

However, the masts, which are over 200 feet high, are 5 in number and arranged in a radio range station pattern with a diagonal distance of 600 feet, which would be suitable for sending a beam at frequencies between 200 and 400 Kcs. for guiding aircraft. It is unlikely that D. F. equipment would have such large dimensions, for it would indicate reception of low frequency whereas the need for D. F.'ing on low frequency is slight.



MILLE, MARSHALLS

"A" - 9 STICK MASTS, 75 FEET HIGH
"B" - 3 STICK MASTS, 75 FEET HIGH, FOR COMMUNICATIONS
"C" - POWER OR COMMUNICATIONS LINES

Three views of an unidentified installation on Mille, which is thought to be air navigational aid.

The installation consists of nine type "5" spliced wood stick masts (see page 2.03) arranged in a staggered pattern along the shore.

Note pattern in vertical stereogram. These nine masts are guyed from the top, whereas the communications masts are not.

NAVIGATIONAL AIDS
JAPANESE (CONT.)

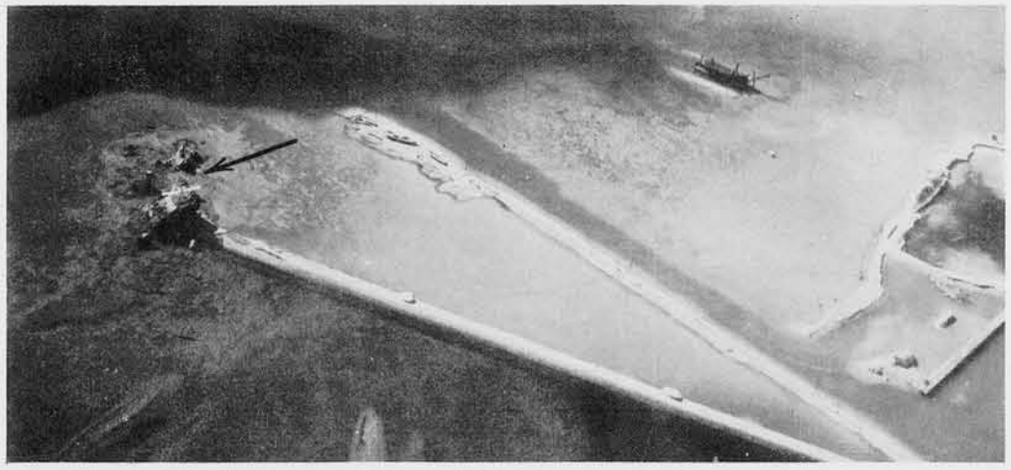
This installation at Chichi Jima is an unusual device which may be used for a Ship Navigational Aid.

It is difficult to delineate its exact construction from these photos, but certain forms seem evident: a long horizontal platform with vertical members (which are assumed to be dipoles) arranged as a fence on a catwalk, but some extending an equal distance below.

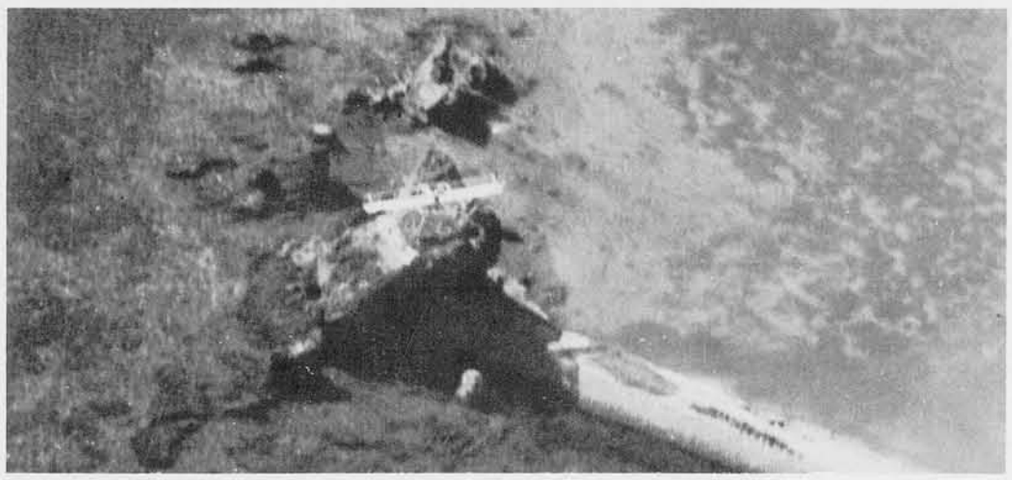
The whole 35 foot horizontal member appears to be capable of rotating on its base. The base, constructed with diagonal cross bracing, is about 15 feet high by 18 feet square in plan view.

The installation is located on the end of a breakwater, so as to command the entrance to the harbor.

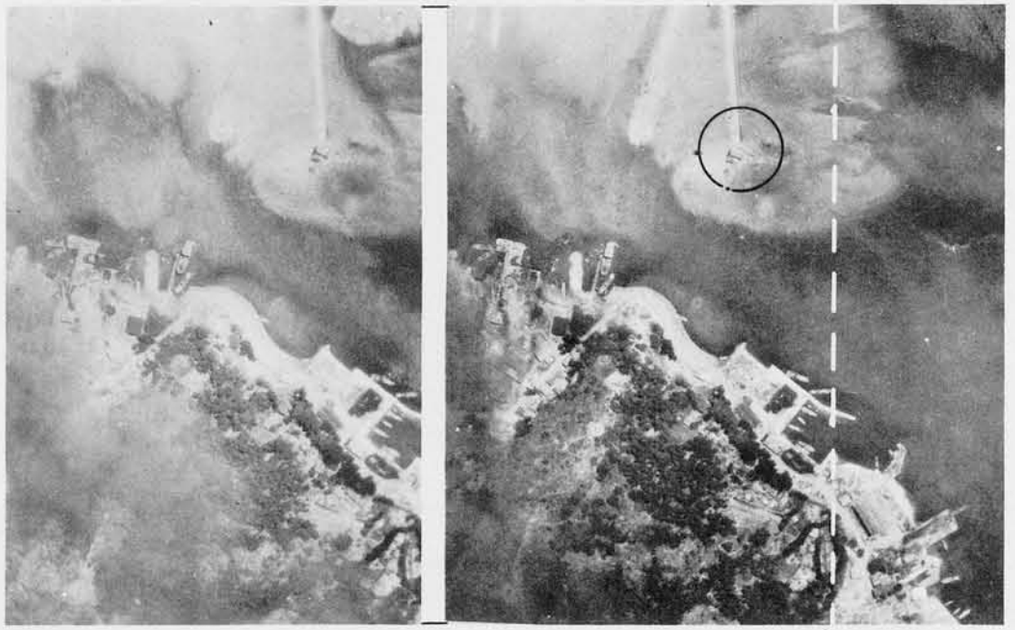
If a Navigational Aid, this installation is undoubtedly for guiding surface vessels and probably operates at high frequencies (30 to 80 Mcs.).



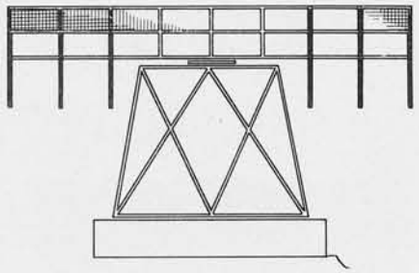
CHICHI JIMA

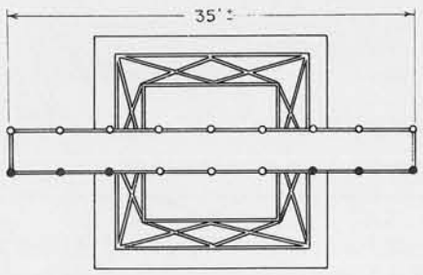


CHICHI JIMA



CHICHI JIMA, BONIN IS.





CHICHI JIMA

NAVIGATIONAL AIDS
SUMMARY (GERMAN)

The Germans have developed several types of Navigational Aids, operating at high frequencies, for homing aircraft and for directing aircraft to bombing objectives.
Below is a table listing the most important standardized types.

In addition to those listed here are Lorenze Stations for homing aircraft, Benito D.F. stations for fighter control, broadcast and radio range stations, portable transmitters dropped near target, ship and submarine navigational beams and others.

FIVE IMPORTANT GERMAN AIR NAVIGATIONAL AIDS

NAME	SIZE OF AERIAL	TOP OF AERIAL ABOVE GROUND	FREQUENCY IN MEGACYCLES PER SECOND	RANGE IN NAUTICAL MILES	USE
KNICKEBEIN	147' WIDE DIAMETER OF TRACK = 98' 20° BEND	50'	30 TO 33.4	215	BLIND BOMBING & NAVIGATION (AZIMUTHAL NAV. BEAM)
RUFFIAN	70' WIDE	30'	66.5 TO 75	215	BLIND BOMBING (AUTOMATIC BOMB RELEASE OVER TARGET - NOW OBSOLETE)
BENITO	50' - 70' WIDE	30'	38.4 TO 45	85-175	BLIND BOMBING (AZIMUTHAL AND RANGING NAV. BEAM FOR BOMBERS & FIGHTERS)
WIND JAMMER	LOWER - 112' WIDE UPPER - 45' WIDE DIAMETER OF TRACK - 56'	82'	38.4 TO 42.3	85	G.C.I. CONTROL OF FIGHTER A/C
ELEKTRA	3 - 300' MASTS 2 MILES APART	300'	0.29 - 0.48	1300	LONG RANGE NAV. BEAM (A/C D.F.'s ON BEAM)

There are no photos shown here of the "Elektra". In lieu of pictures, the following description is given:

The complete installation consists of 3 masts about 300 feet high, laid out in a straight line at regular intervals of 1½ to 2 miles.

The three parts are separate but complimentary. Each mast is accompanied by a small hut adjacent. All three masts and huts are connected by buried cables to the transmitter, which is at or near the central mast.

Elektra is a low frequency fixed installation operating from 0.29 to 0.48 Mcs., and has a range of 1300 nautical miles.

Operation: Aircraft D.F.'s on station to determine which of several equi-signal beams he is on. Beams remain fixed.

Beams remain fixed as to direction, and probably are seldom changed for any given section.

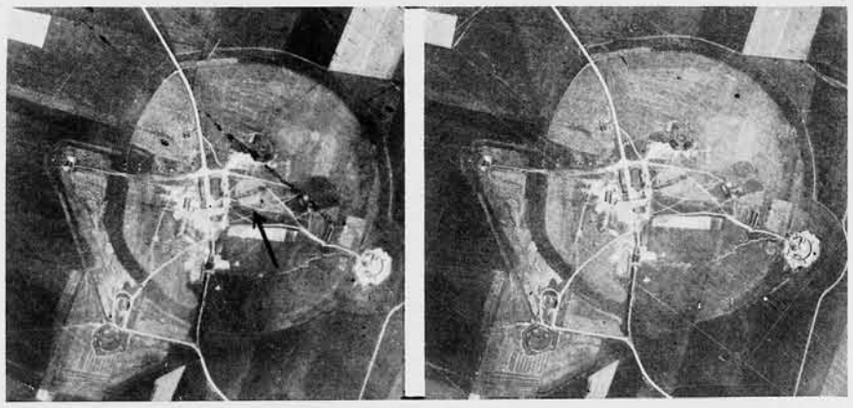
[redacted]

NAVIGATIONAL AIDS
GERMAN

(R.F. - 1/10000)

KNICKEBEIN

The "Knickebein" is probably the best known of the German Navigational Aids. Its name is derived from the pronounced bend in the antennae framework. This bend can be detected by the shadow visible in the above stereogram. The track is 98 feet in diameter.



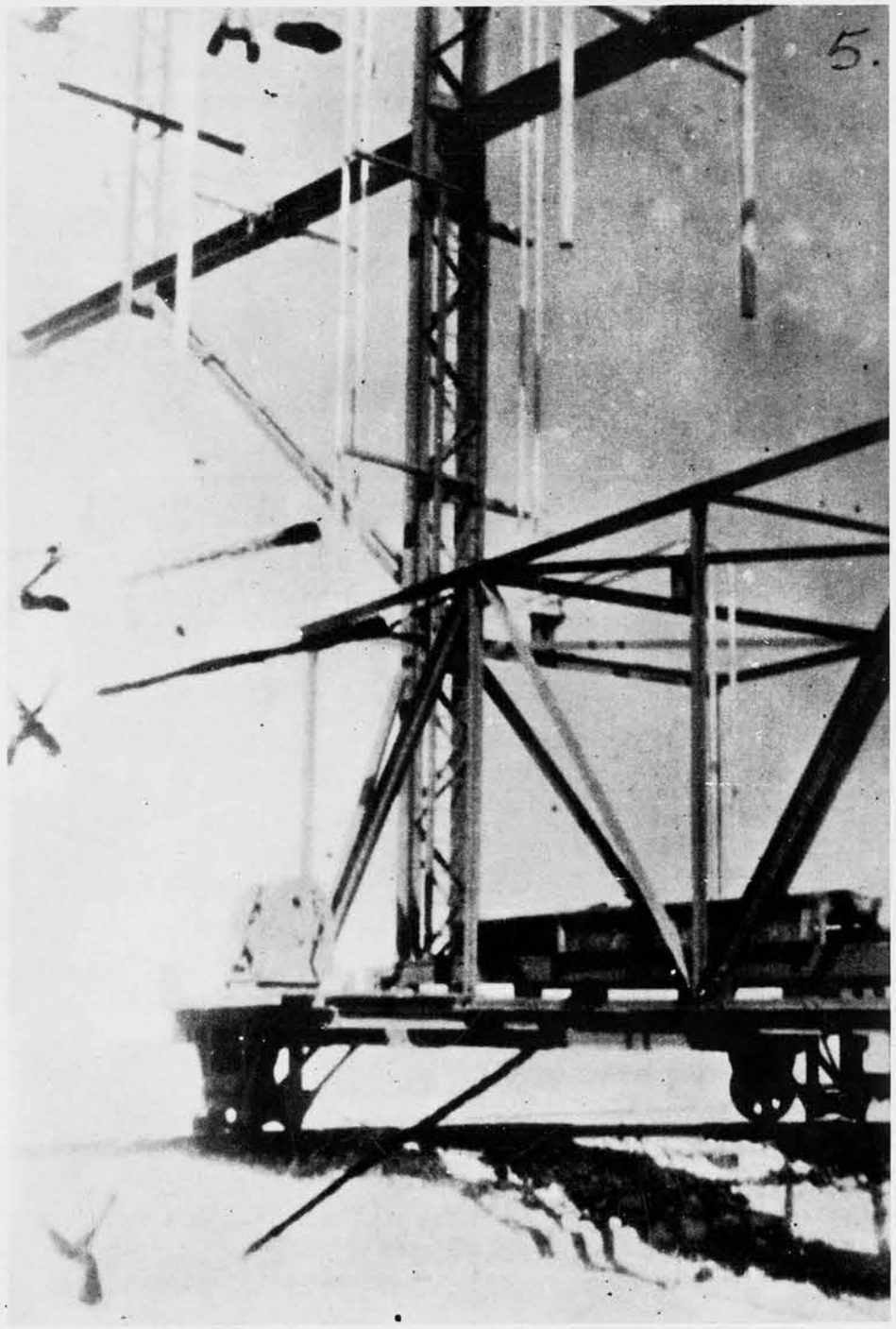
(R.F. - 1/9000)

KNICKEBEIN

The "Knickebein" is an "Azimuthal Navigational Beam" with no provision for ranging. The pilot flies down the beam as in the case of an ordinary beacon or radio range. The frequency band is from 30 to 33.4 mcs.

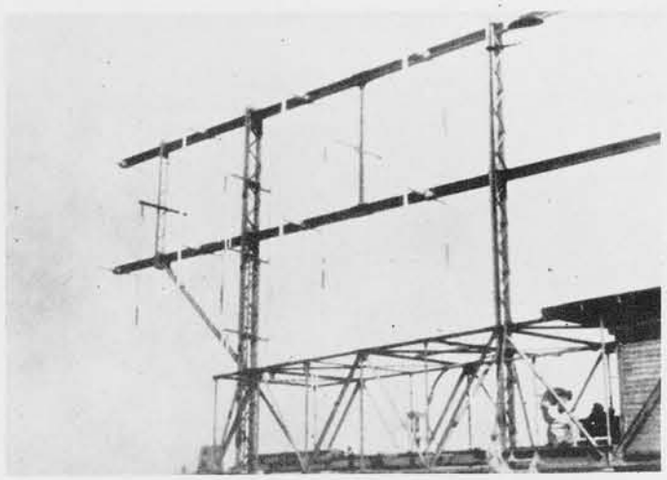
KNICKEBEIN

The above oblique is a well known photo of an early design which is not typical of the standardized form now well known as the "Knickebein".
This heavily constructed installation operates in much the same way as the "Knickebein", however, by transmitting a high frequency azimuthal beam.



KNICKEBEIN

Closeup of antennae shows a series of dipoles, similar to those used with Radar equipment. Track and bogies for rotation of entire instrument are visible here. Cabin is built into framework of aerial and rotates with aerial.



KNICKEBEIN

LEFT: View showing the 4 groups of dipoles and reflectors. Note corner of control shack in lower right.

The only other installation with which the Knickebein might be confused is the "Windjammer".

The Windjammer has no bend in its aerial as has the Knickebein.
The Knickebein has a wider and lower aerial than the Windjammer, and the diameter of the track is greater in the case of the Knickebein.

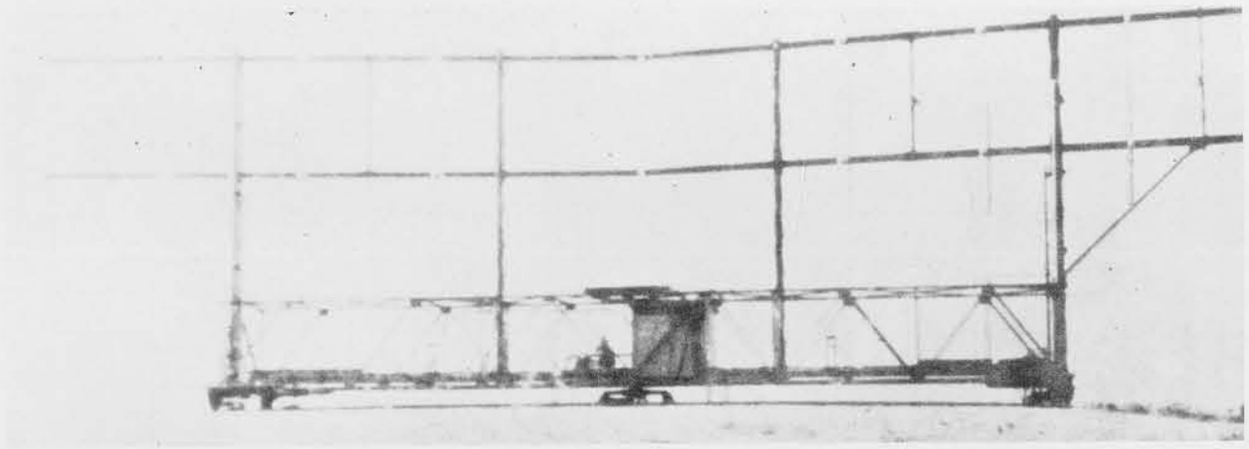
RIGHT: View taken across top of control shack showing center point of bend. There are two sets of four dipoles with reflectors on each side of the bend. The included angle of the bend is 160°.

KNICKEBEIN

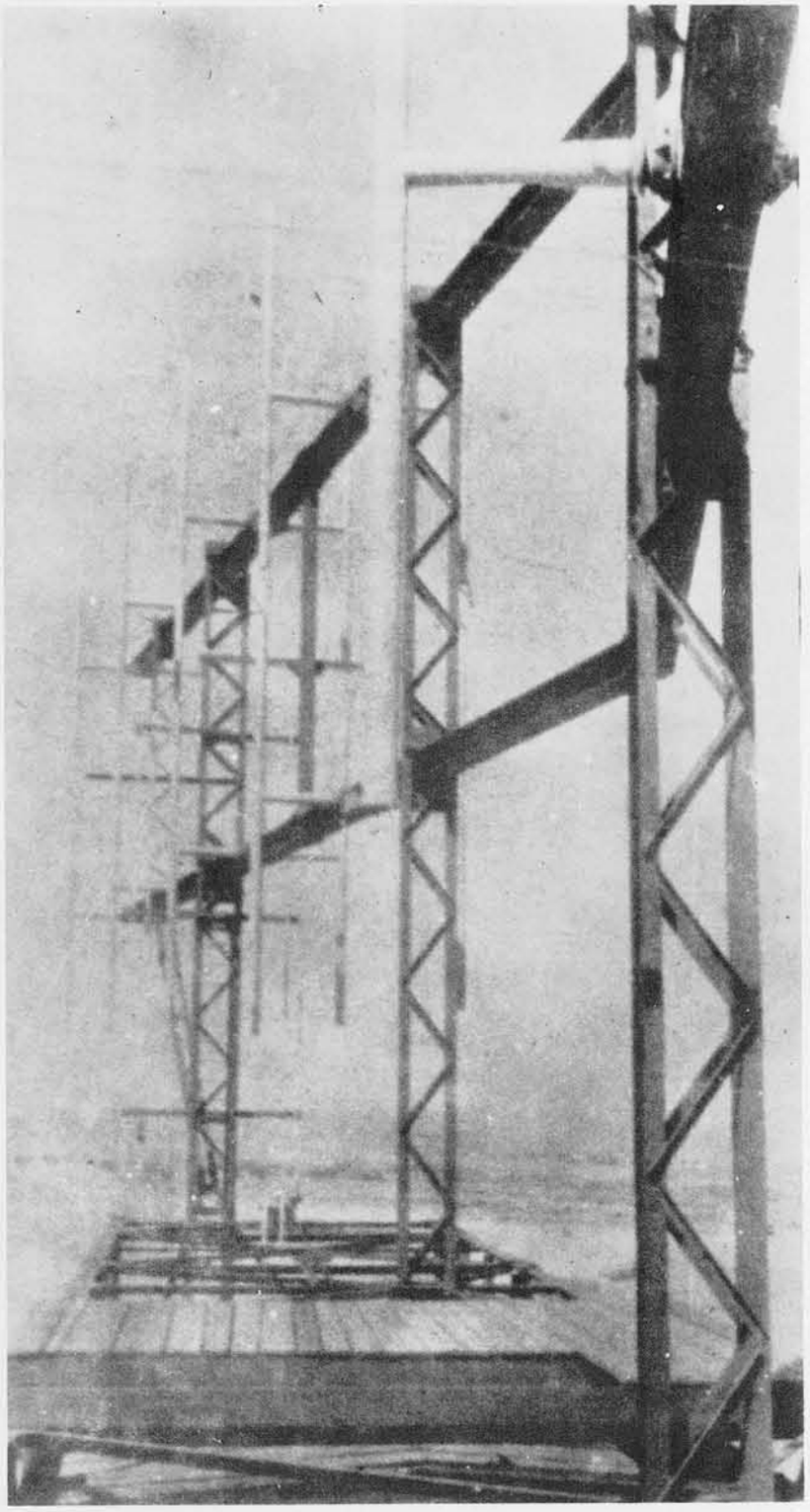
LEFT: Detail of central pivot of turntable. Weight is carried by bogies at ends, which travel on the circular track.
The small cabin is above this point (the Windjammer's cabin extends the full diameter of the track).

BELOW: Comprehensive view of front of "Knickebein".. Aerial is 147 feet wide, track is 98 feet diameter, and the top of the aerial is 50 feet above ground.

Special equipment is necessary in the aircraft. Signal is a dot dash tone and shows on a meter indication.

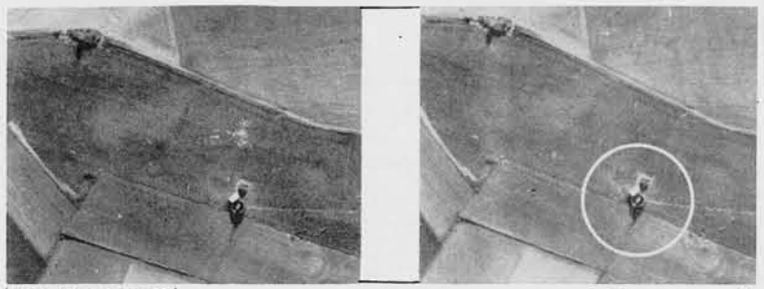


KNICKEBEIN



KNICKEBEIN

NAVIGATIONAL AIDS
GERMAN (CONT.)



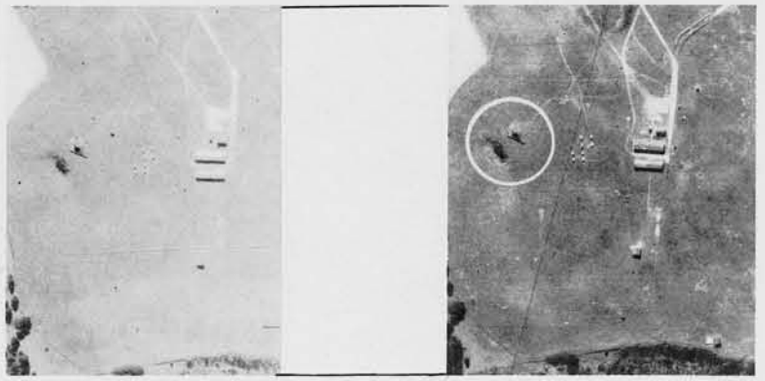
(NO PARALLAX) (R.F. - 1/7500±)

RUFFIAN

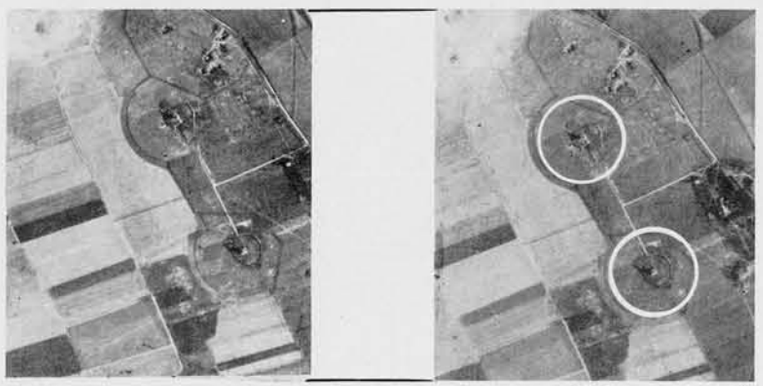
The "Ruffian" is a blind bombing navigational aid which is now obsolete. It employed three sharply defined beams, one over target and two at right angles to target beam. These beams created an automatic bomb release over a specified target (London). Target beam and cross beams were received in aircraft at slightly different frequencies by two different receivers.

Frequencies were between 66.5 to 75 mcs.

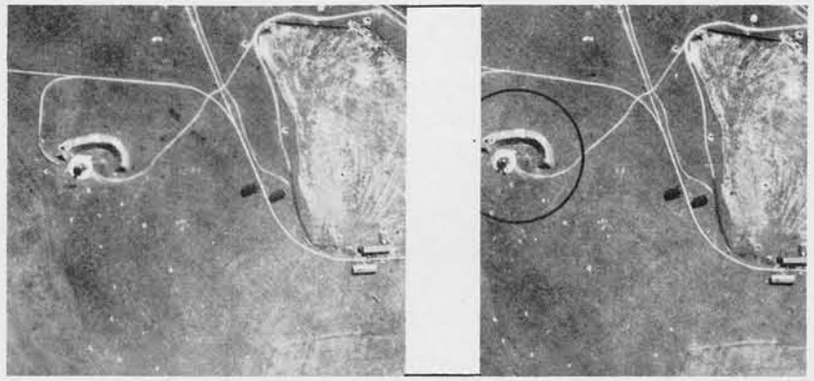
Antenna consisted of a 70 foot cross arm, 30 feet above the ground, with vertical aerials.



BENITO (R.F. - 1/7500±)



BENITO (R.F. - 1/10000±)



(R.F. - 1/7500±)

BENITO

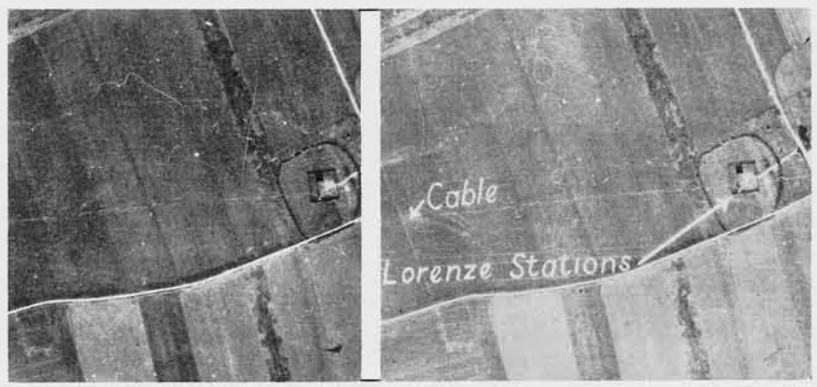
This installation appears to be a navigational aid and resembles a Benito type. Identification is not positive however. The stereogram is included to show the variety of forms such equipment may assume.

LEFT:

The Benito Navigational Aid for bombers is a transmitter of high frequency beams (38.4 to 48 mcs.) and is used for blind bombing giving both range and azimuth.

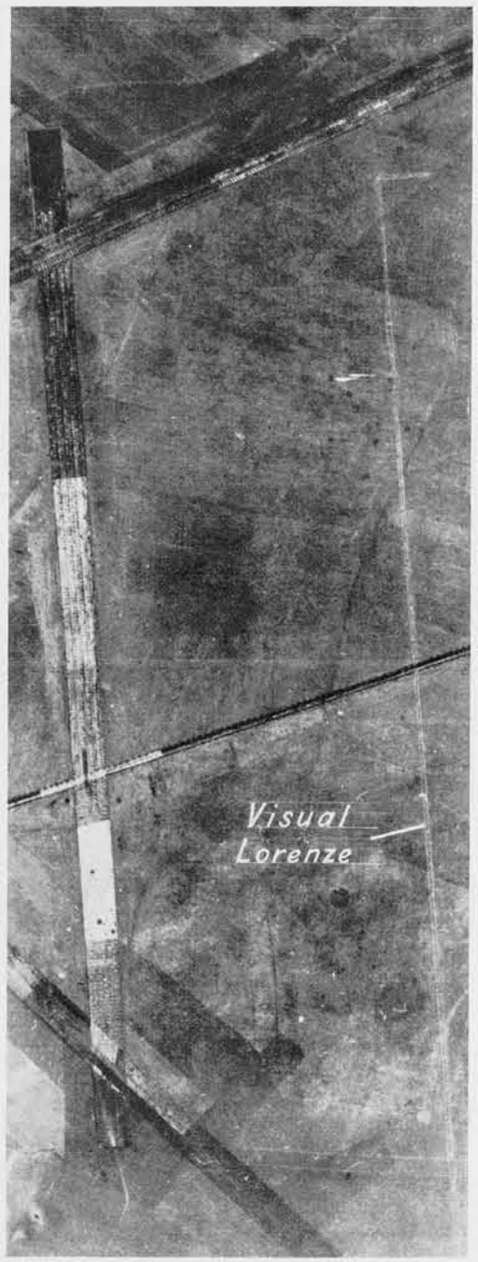
The antenna consists of a rotating cross arm of from 50 to 70 feet supported by "Y" type bracing and containing (in the case of the range antenna) a broadside array of 7 pairs of dipoles with reflectors. Two instruments are needed, one for range and one for azimuth.

The Benito can best be identified from aerial photographs by the shadow of the "Y" type cross arm supports which can be seen clearly in two stereograms shown here.



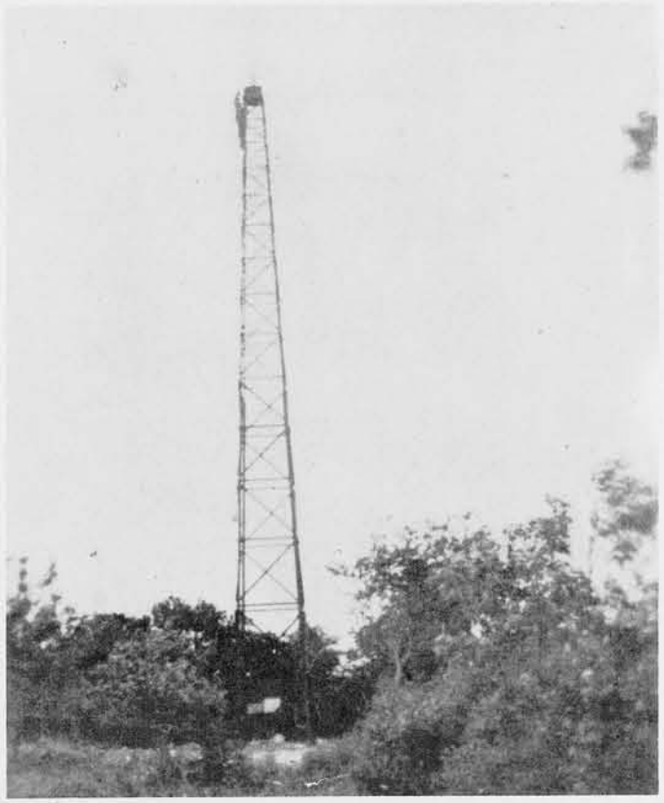
(R.F. - 1/10000±)

VISUAL LORENZE STATIONS



VISUAL LORENZE STATIONS

ABOVE & LEFT: Visual Lorenze Stations are found on or near German airfields. Their purpose is to assist pilots in landing. The extensive white scar pattern created by buried cables is the best identification feature.



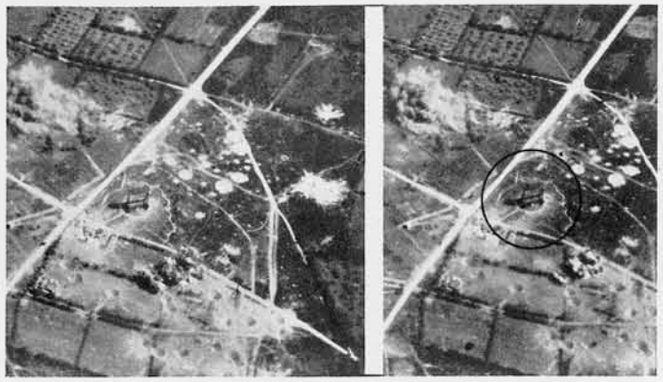
WINDJAMMER MONITOR

On this page are views of the latest German Air Navigational Aid -- the "Windjammer".

The Windjammer is a Radio-Navigational Aid used in connection with German G. C. I. stations in increasing numbers. Its function in fighter control is supplementary to the Giant Wurzburg and it is less subject to jamming. The Windjammer gives slant range and bearing of aircraft.

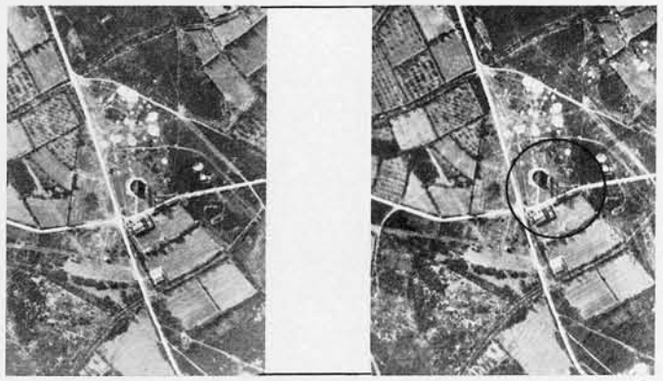
The track is 56 feet in diameter. The widest aerial (the lower aerial) is 112 feet wide. The upper aerial, shaped like a letter basket, is 45 feet wide. Top of aerial assembly is 82 feet above ground.

The elongated cabin, which rotates with the aerial, is divided into three main parts: the central section houses the control gear for the four electric motors, which rotate the structure; the right end (facing the aerial) contains the transmitting equipment; the left end contains work space.

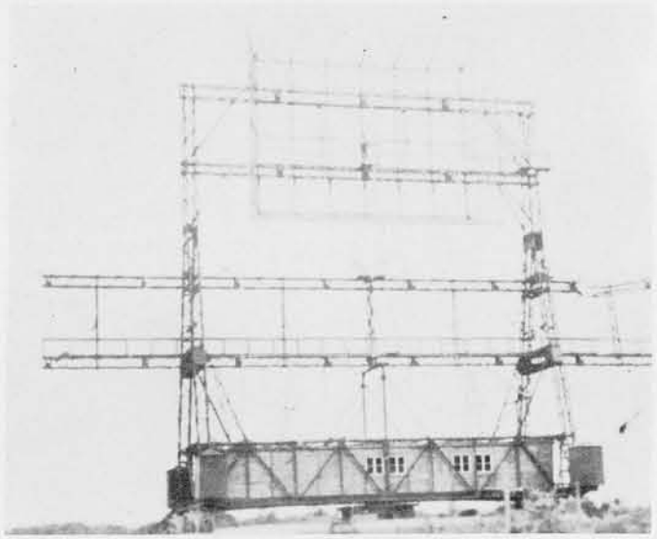


WINDJAMMER

In both of the above stereograms, it is clearly evident that this installation is a Windjammer and not a Knickebein. The lower aerial is 112' x 14' (exclusive projection of the dipoles); the upper aerial is 45' x 30', the top being 82 feet above ground.



WINDJAMMER (R.F. - 1/10000±)



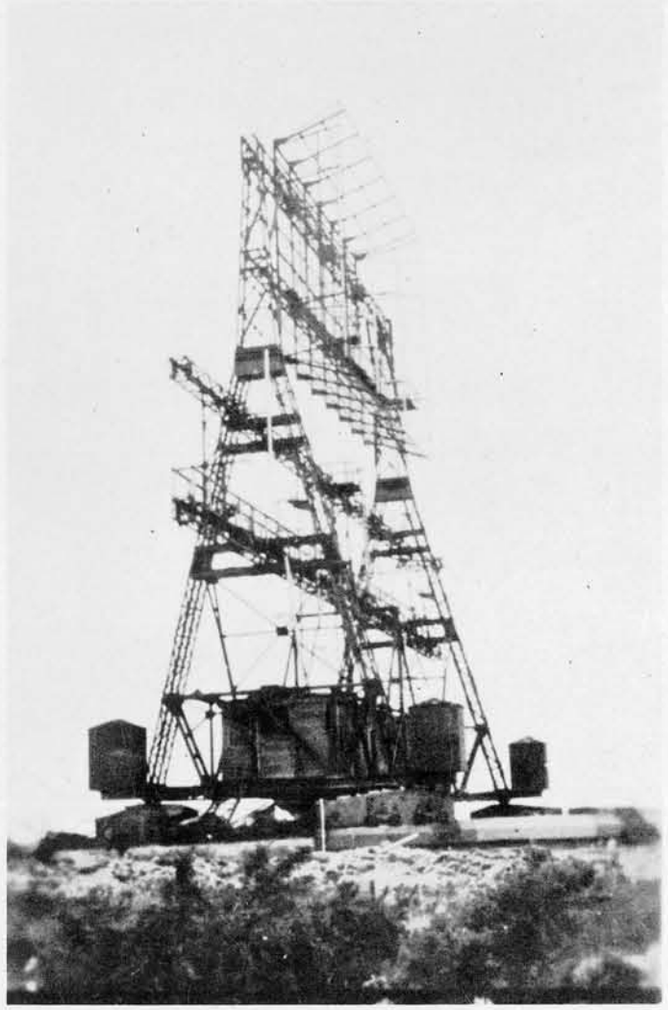
WINDJAMMER

The Windjammer (sometimes called "Benito for Fighters") operates at frequencies between 38.4 and 42.3 Mcs. Its range is about 85 nautical miles for aircraft at 10,000 feet altitude.

The Windjammer installation is accompanied by a Monitor Receiver which is 1/4 mile distant. The monitor consists of a 100 foot high lattice mast surmounted by an 8 foot high aerial (a hollow pipe).

This monitor may also be used for communications with the A/C in connection with G. C. I. control.

An underground cable can usually be seen running from the monitor mast to the Windjammer turntable.



WINDJAMMER

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-5

5.01 — 5.99

ELECTRONICS COMBINATIONS

ELECTRONICS COMBINATIONS

MARCUS ISLAND

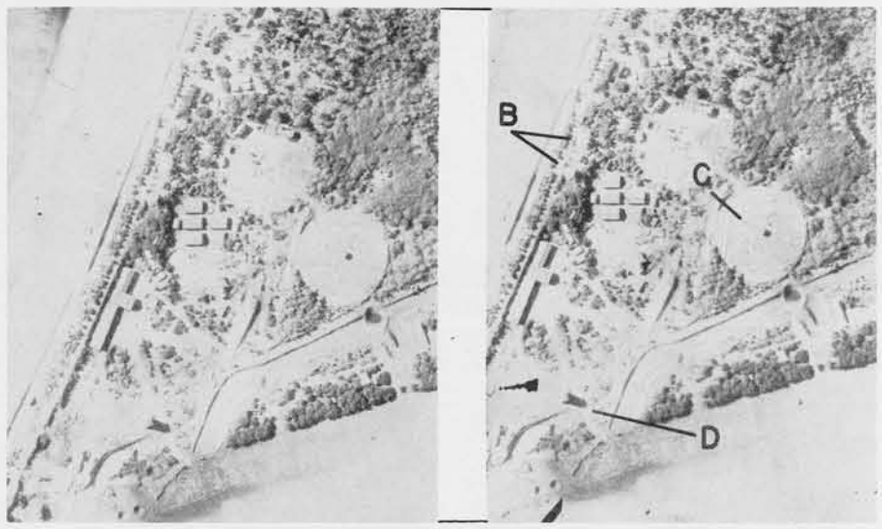
"Electronics Combinations" section is composed of a selected group of Japanese controlled localities which afford particularly good opportunities for studying several types of electronics installations and their relationship to each other.

On Marcus Airfield, shown on this page, can be seen Communications, D.F., and Radar in combination.

(R.F. - 1/9000)

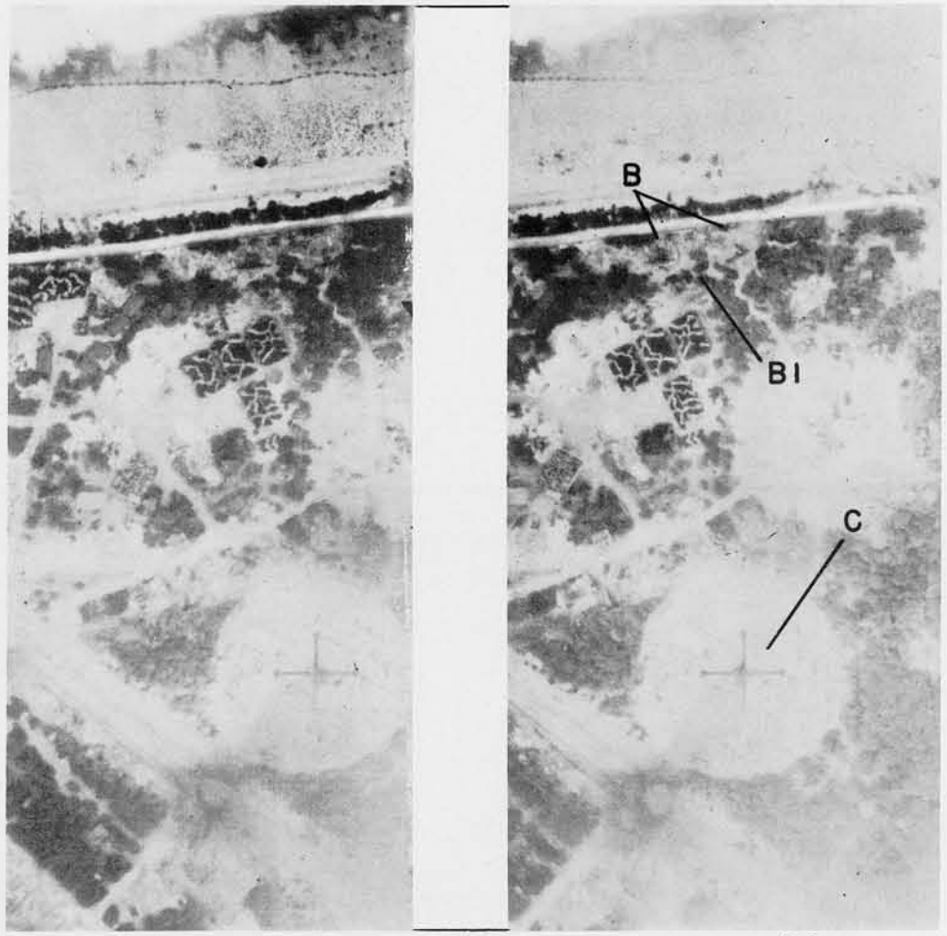
MARCUS

"A" - MEDIUM FREQUENCY COMMUNICATIONS CENTER; "B" - TWO GUADALCANAL TYPE RADARS; "BI" - GENERATOR BUILDING FOR RADARS; "C" - MEDIUM FREQUENCY ADCOCK D.F.: "D" - HIGH FREQUENCY D.F. TOWER.



(R.F. - 1/6700)

MARCUS



(R.F. - 1/3000)

MARCUS

MARCUS

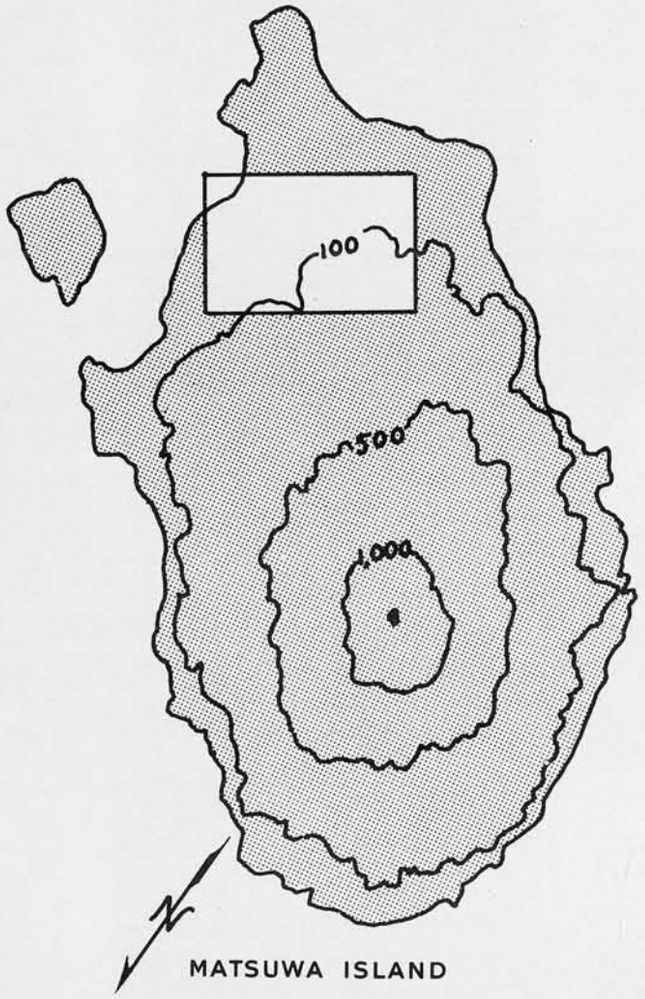
ELECTRONICS COMBINATIONS

MATSUWA ISLAND

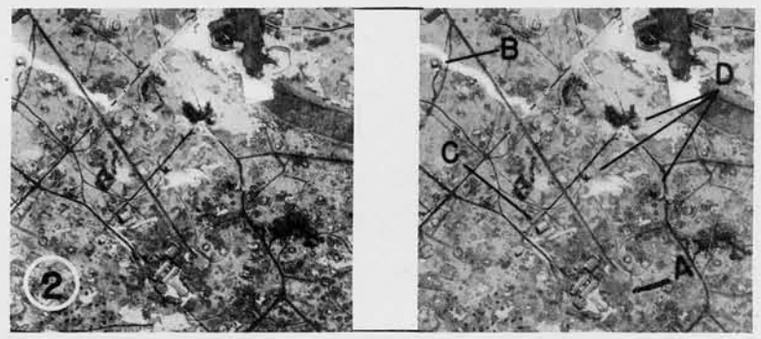
(R.F. - 1/11000)

NORTHERN PORTION OF MATSUWA AIRFIELD

The airfield at the southern tip of Matsuwa contains a fairly complete military electronics system. This set-up is unusual in one respect, however, for it does not include a large communications center with lattice masts, as do most large Japanese airfields. However, Medium and High Frequency stations, using stick masts, are present.



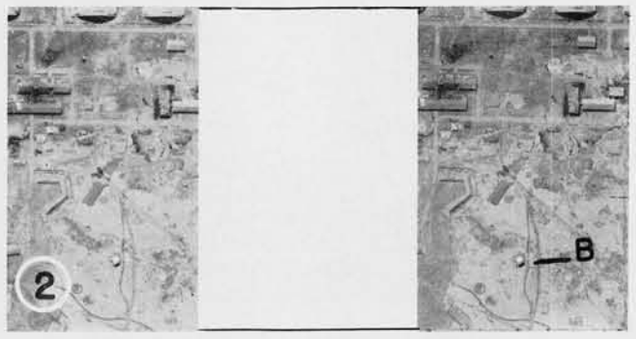
MATSUWA ISLAND



(R.F. - 1/11000)

D. F. CENTER

"A" - D. F. Center Building "B" - High Frequency D. F. Tower
"C" - Probable Generator Building
"D" - Three High Frequency D. F. Towers



(R.F. - 1/7500)

D. F. TOWER

Detail at larger scale of D. F. Tower shown in stereogram to the left. This is probably a High Frequency Adcock.

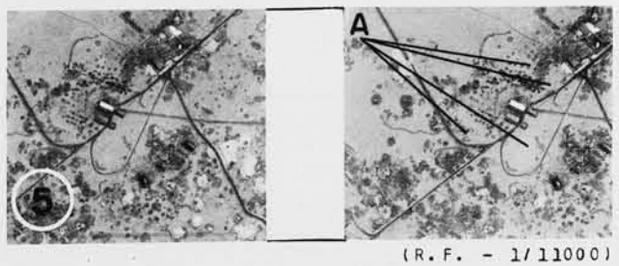
KEY TO INSTALLATIONS:

1. PROBABLE D. F.
2. LARGE D. F. CENTER
3. RADIO WEATHER STATION AND D. F. TOWER
4. RADAR STATION
5. COMMUNICATIONS STATION

CONFIDENTIAL

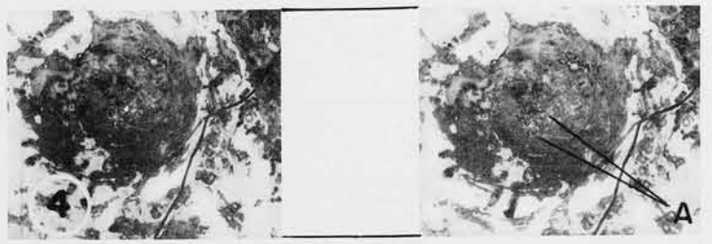
ELECTRONICS COMBINATIONS

MATSUWA ISLAND (CONT.)



(R.F. - 1/11000)

COMMUNICATIONS

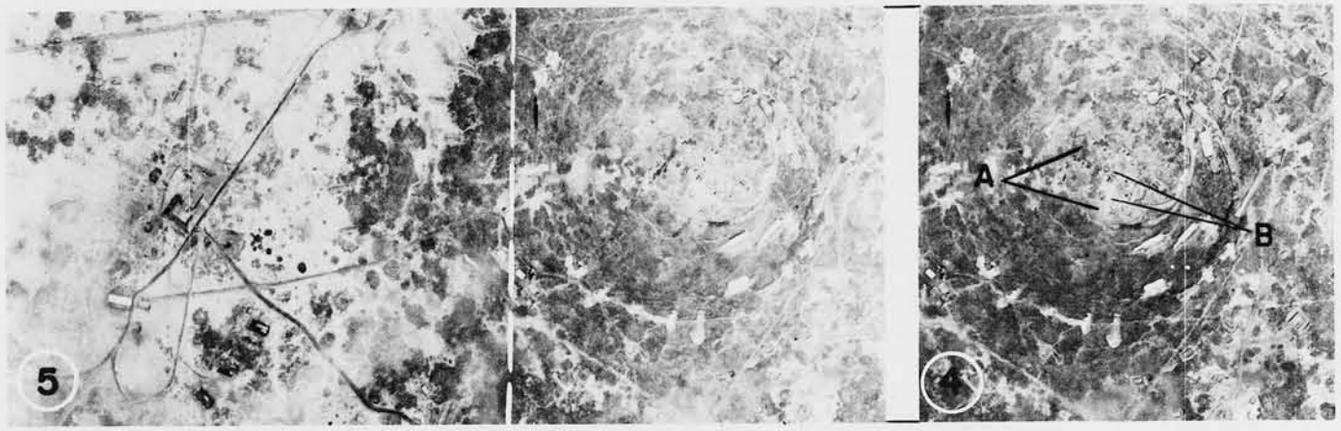


(R.F. - 1/11000)

RADAR STATION

"5-A" - Four of several 75 foot high spliced wood stick masts of Medium Frequency Communications Station.

"4-A" - Two Attu type Radars. It will be noted by comparison with stereogram below, that one of these sets was moved to a new location after this coverage.



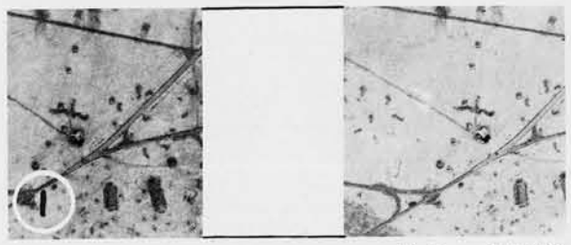
(R.F. - 1/7500)

COMMUNICATIONS AND RADAR

Compare the above installations at each scale. It will be seen that the lower picture (1/7500), which was taken several weeks after the top group, reveals considerable change has taken place at the Radar station. Also note that the smaller scale reveals better detail on the Radio Communications Station than the larger.

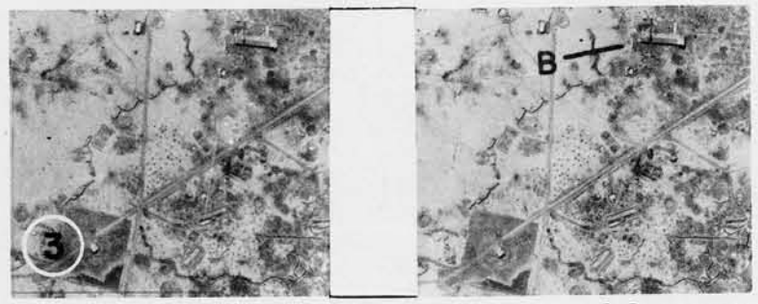
"4-A" - Two Attu Type Radars (siting of one is changed)

"4-B" - Two Mobile Mattress Radars



D.F. TOWER (R.F. - 1/7500)

This tower, situated at the west end of the runway, probably encloses High Frequency D.F. equipment.



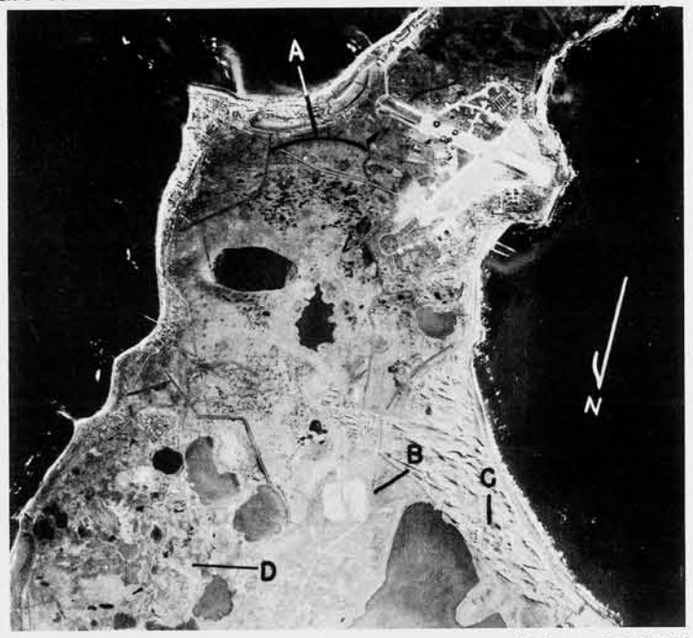
D.F. AND WEATHER STATION (R.F. - 1/7500)

This D.F. tower may enclose a Medium Frequency loop type, similar to Naval D.F.

At the Radio Weather Station (B), the small instrument houses and stick masts for radio are clearly visible.

KURABU CAPE, PARAMUSHIRO

Another airfield, also in the Kuriles, for study of the distribution of various electronics installations.



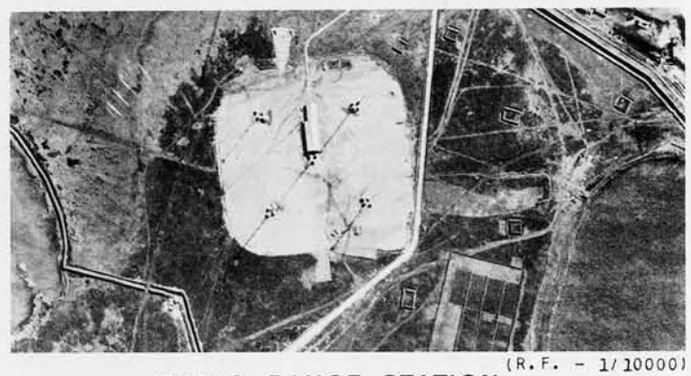
(R.F. - 1/38000)

KURABU CAPE

"A" - D.F. CENTER
"B" - RADIO RANGE STATION
"C" - MEDIUM FREQUENCY COMMUNICATIONS CENTER
"D" - TWO GUADALCANAL TYPE RADARS

(R.F. - 1/10000)

D.F. CENTER



(R.F. - 1/10000)

RADIO RANGE STATION

ELECTRONICS COMBINATIONS

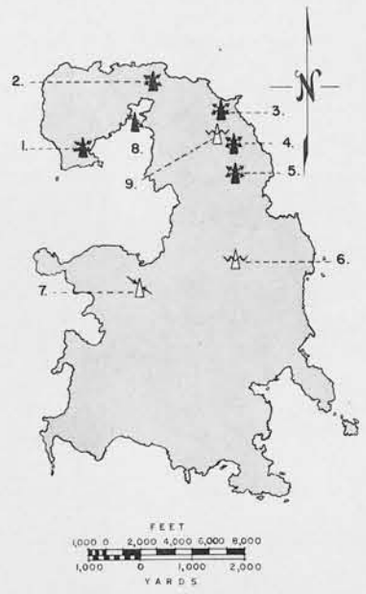
CHICHI JIMA

Chichi Jima, in the Bonins, serves as a good illustration of a small area of Japanese land, well endowed with electronics installations.

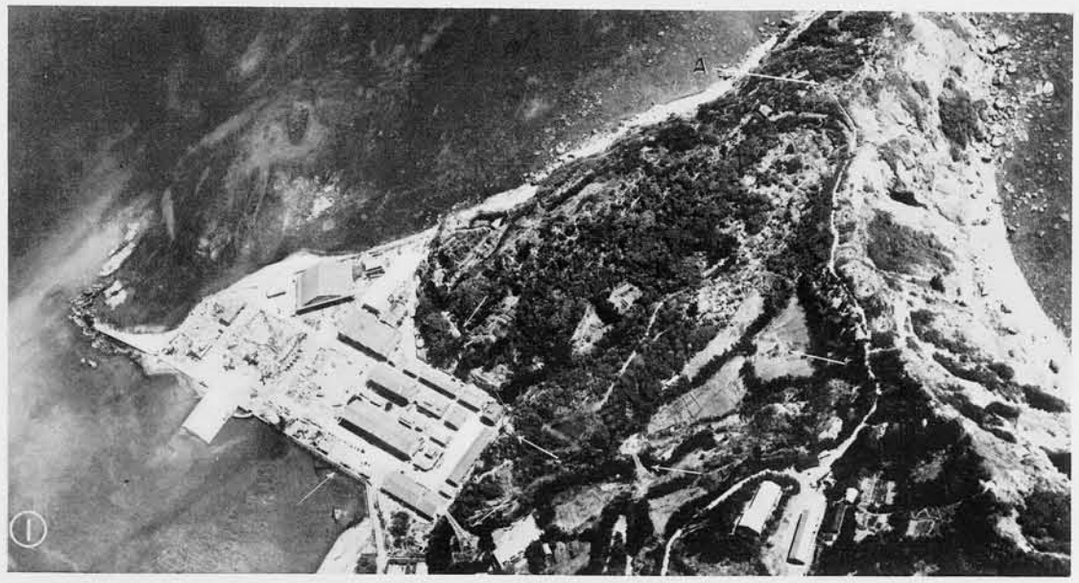
Especially worthy of note is the elaborate development of radio communications, there being five powerful long range stations within an area of two miles square.

In the area covered by these photos, the following Electronics installations have been found: five powerful Communications Stations, operating on medium and low frequencies: two search Radar Stations; one large Direction Finding Center; and one probable Navigational Aid for guiding ships into the harbor.

Numbers on photos are keyed to sketch map at right.

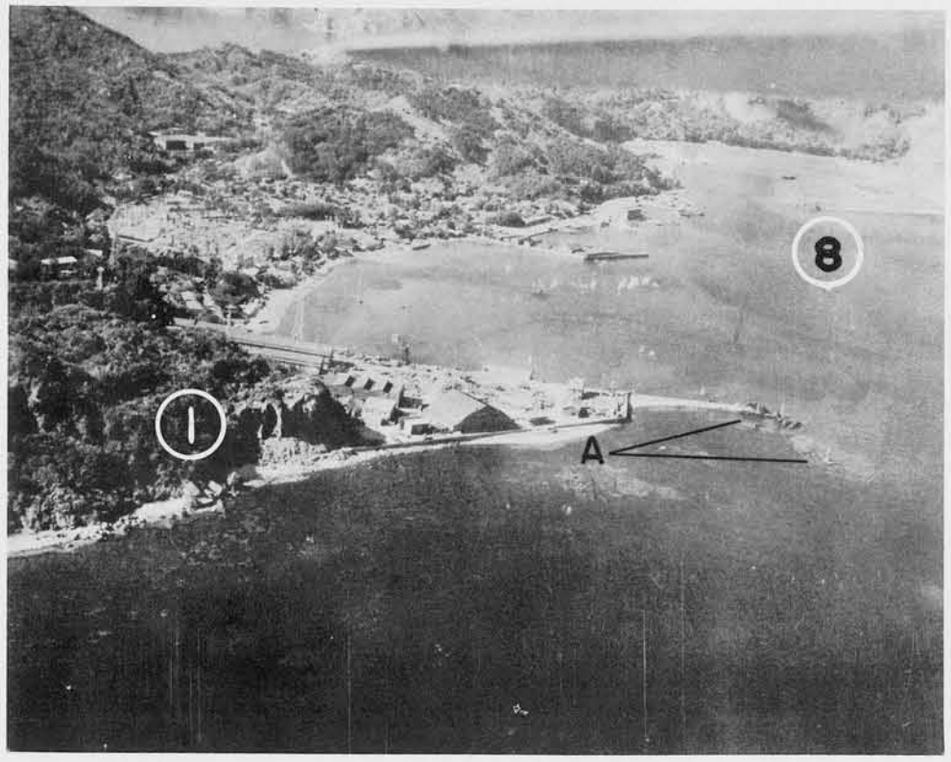


CHICHI JIMA, BONIN IS.



COMMUNICATIONS

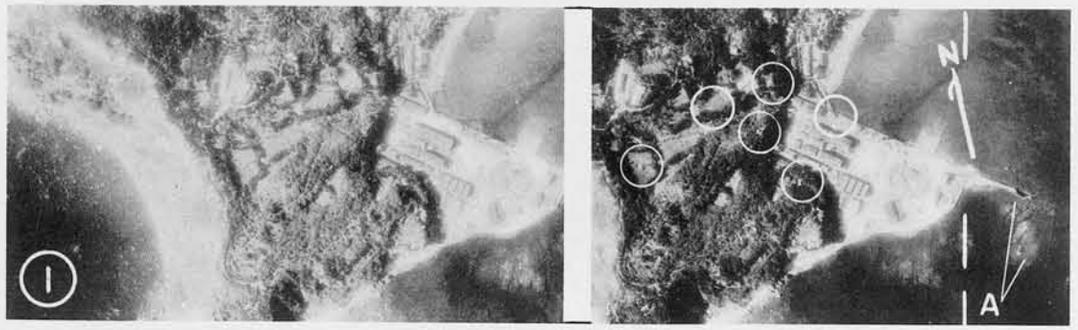
"A" - See page I.27



CHICHI JIMA

Oblique view of harbor showing low frequency station at seaplane base and probable ship navigational aid in background. "A" represents light beacons.

COMMUNICATIONS



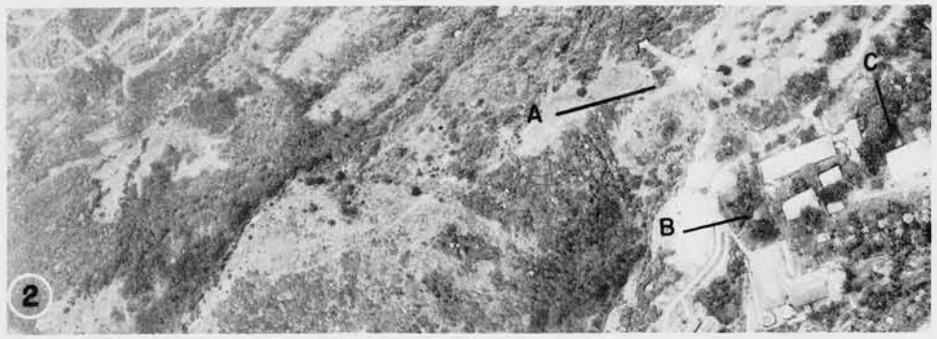
(R.F. - 1/11200)

COMMUNICATIONS

Six mast low frequency communications station at seaplane base. There may be two low frequency transmitters present. "A" - indicates light beacons.

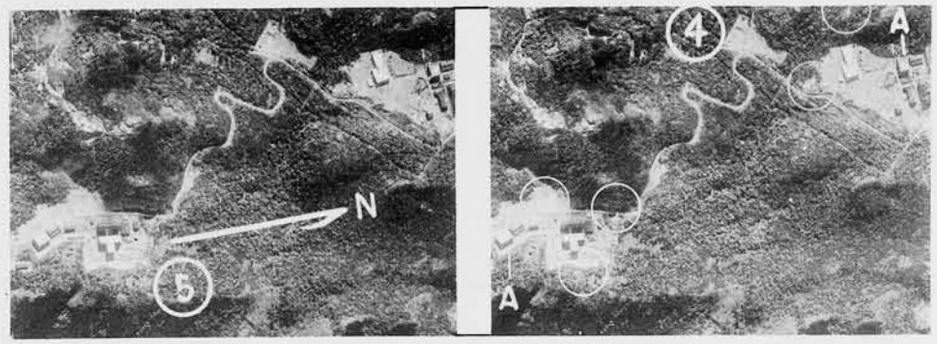
ELECTRONICS COMBINATIONS

CHICHI JIMA (CONT.)



COMMUNICATIONS

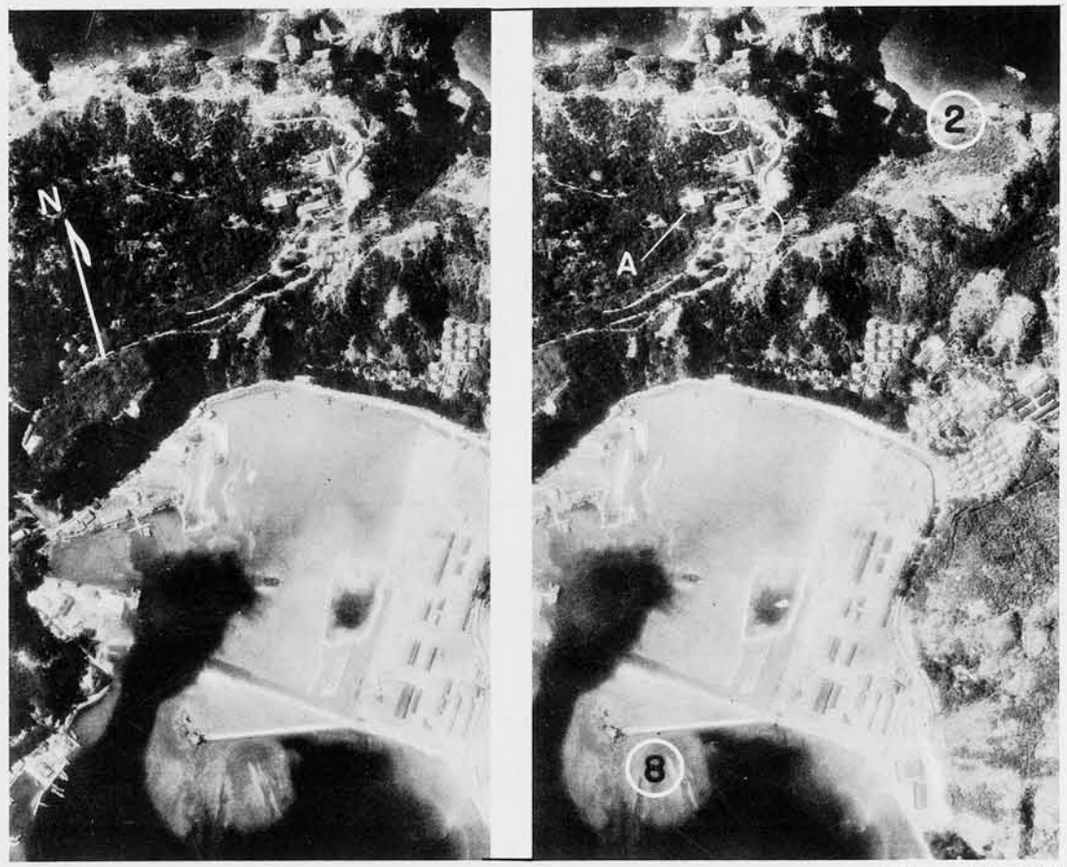
"A" - Low Frequency Lattice mast
"B" - Transmitter building.
"C" - Concrete power plant.



(R.F. - 1/11200)

COMMUNICATIONS

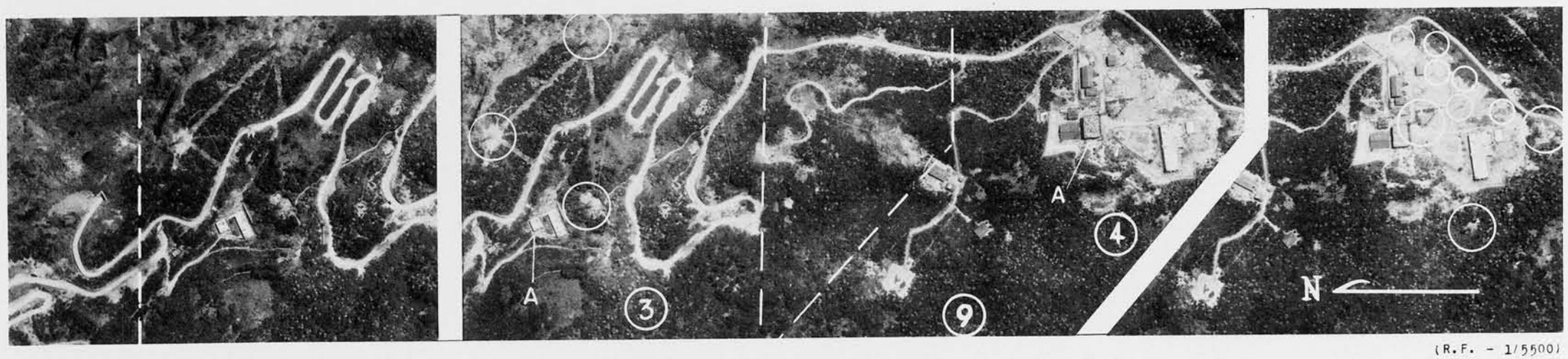
These two communications stations ("4" and "5") are probably medium frequency. The transmitter buildings (white concrete, surrounded by three lattice masts) are but 1800 feet apart. "A" - represents concrete power plant. Stick masts ("4"), indicate multi-frequency (directional?).



(R.F. - 1/11200)

2- COMMUNICATIONS; 8- NAVIGATIONAL AID

Stereogram showing probable ship navigational aid installed at inner end of harbor. Above the harbor is one of the five large communications stations. This is probably low frequency. "A" is concrete power plant. The transmitter building is that building closest to the power plant.

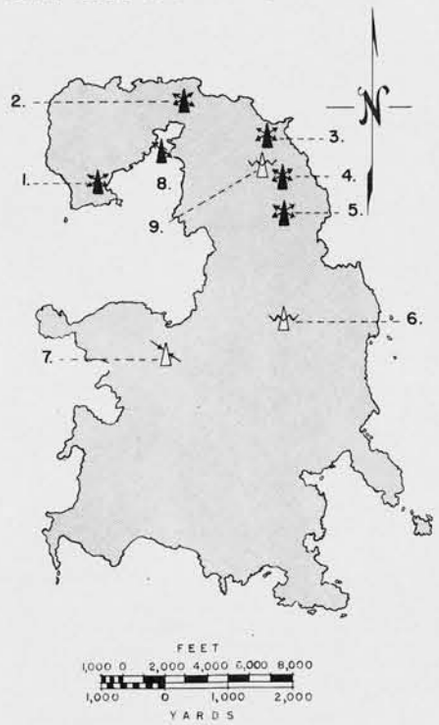


(R.F. - 1/5500)

3 & 4 - COMMUNICATIONS & 9- RADAR

ELECTRONICS COMBINATIONS

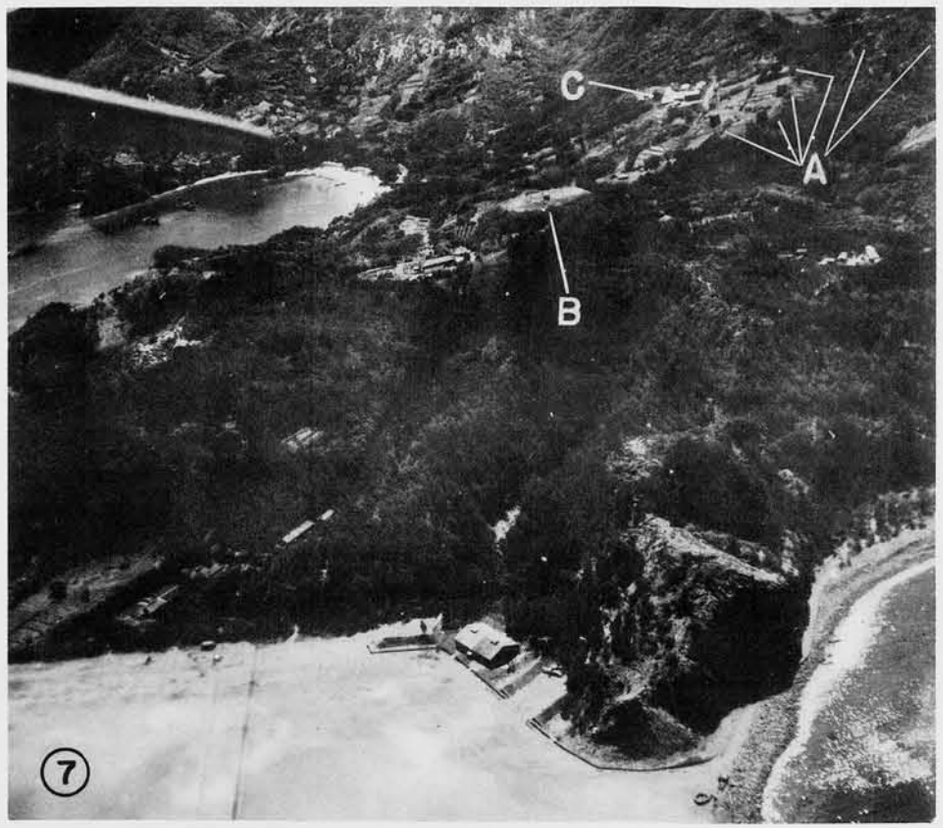
CHICHI JIMA (CONT.)



CHICHI JIMA

On this page are shown some of Chichi Jima's D. F. and Radar installations. The D. F. is adjacent to the airfield which is near the west coast of the island.

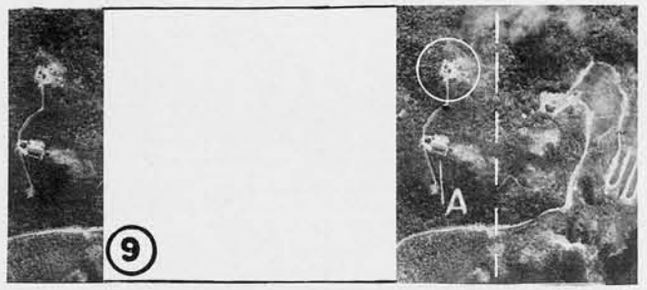
Both Radar sets are mounted on high peaks inland.



DIRECTION FINDING CENTER

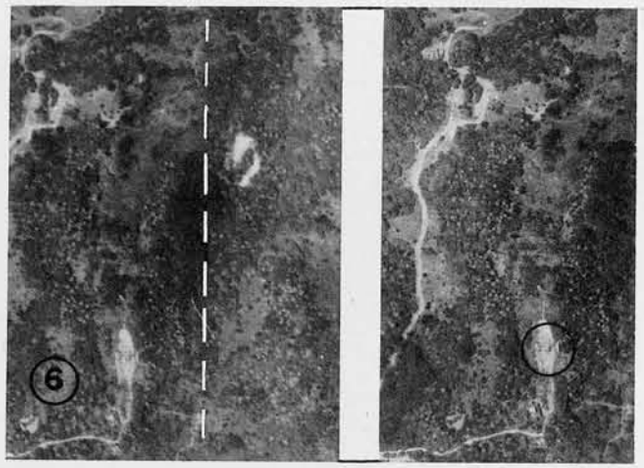
"A" - Six High Frequency D. F. Towers.
"B" - One Medium Frequency Adcock.
"C" - D. F. Center and Reporting Station.

Airfield is located to the right (off the picture). This D. F. center has an unusually large number of High Frequency installations.



(R. F. - 1/11200)

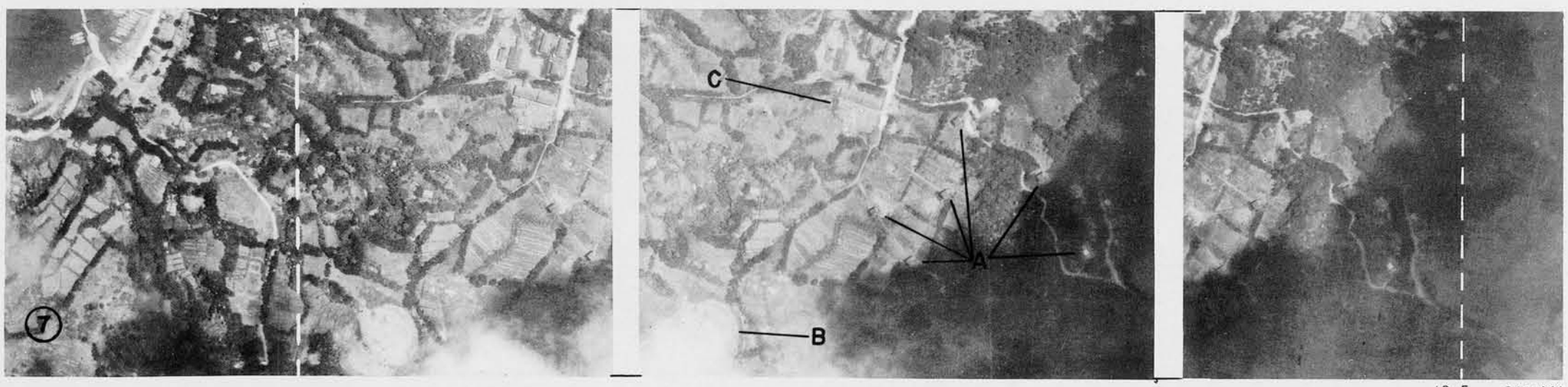
NORTH RADAR STATION



(R. F. - 1/5500)

SOUTH RADAR STATION

"A" - A somewhat standardized building group appears at both Chichi Jima Radar Stations. (Some of the buildings are off photo to lower left in stereogram of south Radar.) Barracks, observation, plotting are probably uses.



(R. F. - 1/5500)

DIRECTION FINDING CENTER

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-6

6.01 — 6.99

RELATED INSTALLATIONS

RELATED INSTALLATIONS

GENERATOR BUILDINGS

"Related Installations" section is composed mainly of reference material on electric power, including power buildings, transformers, transmission lines etc.

The smallest power building types, housing but one Diesel engine and generator, are called "Generator Buildings" (see below). They are used to supply power to some particular military installation. The buildings are usually of wood construction.

The "Military Power Plants" are usually constructed of heavy reinforced concrete and contain two or more Diesel engines and generators. They are nearly always accompanied by a "Water Cooling Tank Building" and an "Oil Storage Building".

These plants supply power to a number of military installations, or to a "Radio Communications Center".

When used with a Communications Center, the generator building itself becomes an integral part of the standard concrete building (which also houses the transmitter, offices, and batteries). The oil and water buildings, however, remain as separate structures.

Several views of "Large Power Stations" show hydro-electric and steam power stations in Japan. Such plants supply power to large industrial areas and to cities. The Japanese have built a great number of hydro-electric plants, which are easily identified on aerial photographs.

In addition to the military power plants and generator buildings shown are several other less used designs as well as the rather common practice of burying the generating equipment or concealing it in a cave.

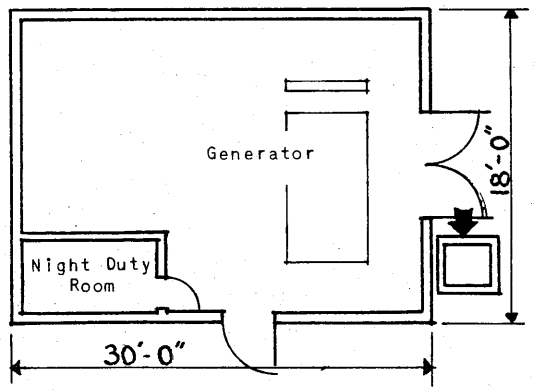
BELOW: Drawings (from captured sketches) of two standard building types which are reported to have been used at Nauru are shown here for reference. These buildings are designed for prefabrication. When built entirely by local contract, these structures may vary in appearance.

In addition to Radar and D.F. generator buildings, the Japanese also use similar prefabricated types for use with anti-aircraft batteries (ground plan 26'x20') and for coastal defense batteries (ground plan 36'x26').

It is thought that the more common design for a D.F. generator building entails the use of buttresses similar to those used on D.F. towers.

ELEVATIONS

PLAN

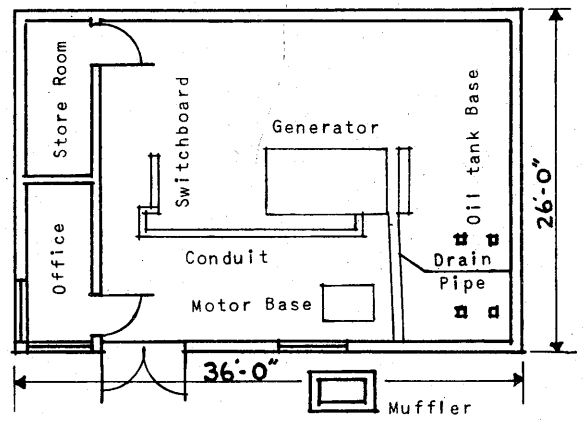


PREFABRICATED GENERATOR BUILDING FOR RADAR. This design was used at Nauru. Building is 18'x30' in plan and is about 9 feet high from ground to eaves. Arrow points to muffler.

GENERATOR BLDG.—RADAR

ELEVATIONS

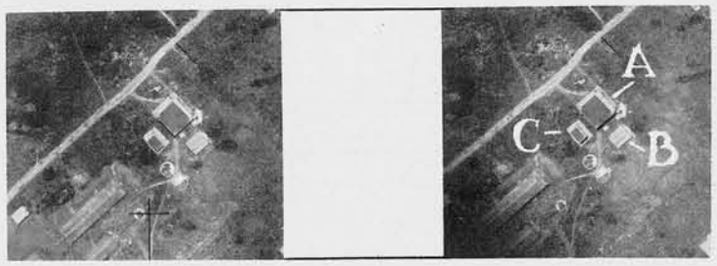
PLAN



PREFABRICATED GENERATOR BUILDING FOR DIRECTION FINDER STATION. This type used at Nauru was 26'x36' in plan and 10 feet high from ground to eaves. (This building may be higher and have buttresses).

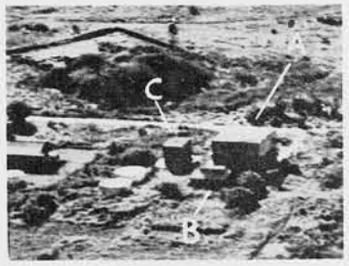
GENERATOR BLDG. — D.F.

RELATED INSTALLATIONS
MILITARY POWER PLANTS

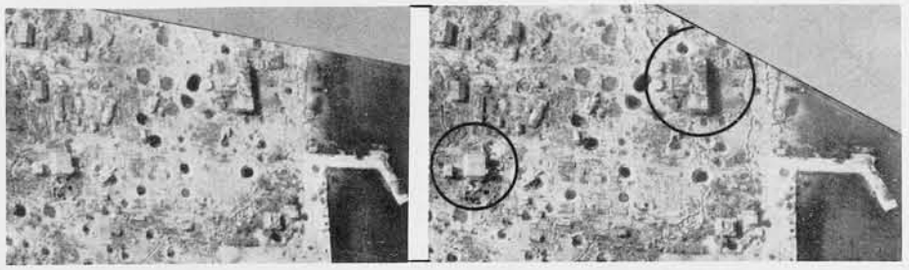


(R.F. - 1/4800)

POWER PLANT GROUP - SAIPAN

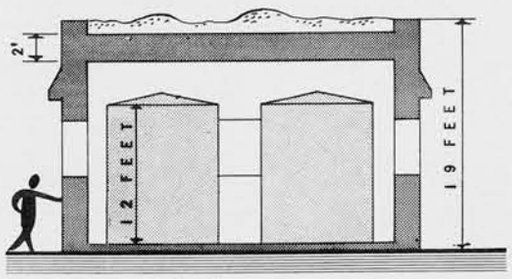


SAIPAN

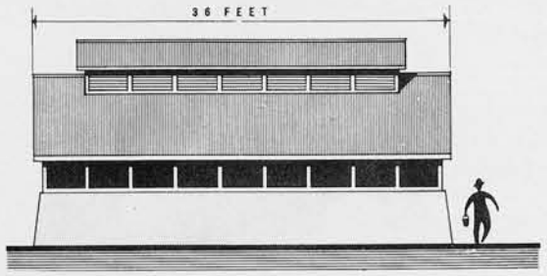


(R.F. - 1/5000)

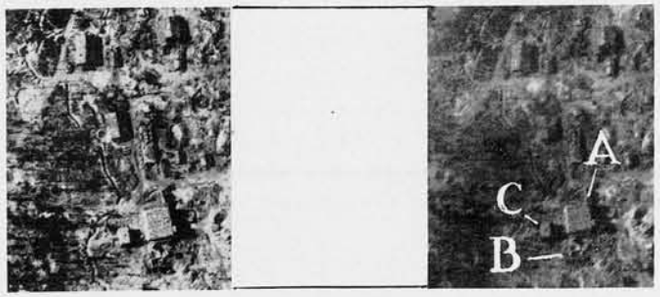
JALUIT



SECTION



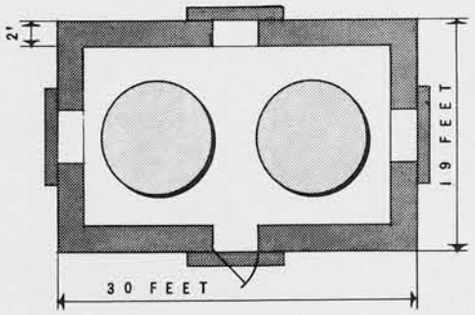
ELEVATION



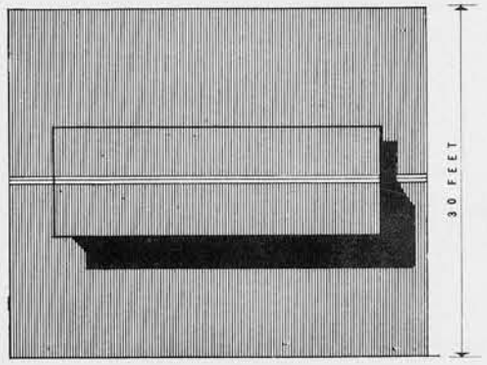
(R.F. - 1/4000)

JALUIT

PLAN

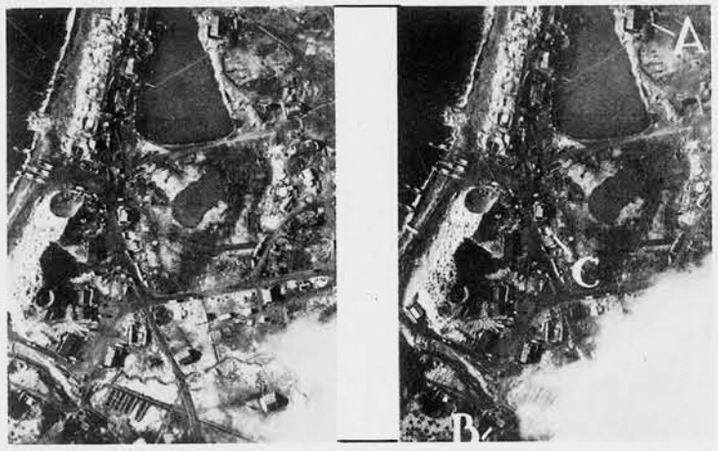


OIL STORAGE BLDG.



ROOF PLAN

WATER COOLING BLDG.



KISKA (R.F. - 1/6200)

KISKA (R.F. - 1/3000)

Japanese power plant groups such as those shown above are fairly well standardized throughout the island areas. They consist of the following:

"A" - CONCRETE GENERATOR BUILDING 48' x55' x22' HIGH
"B" - WATER COOLING TANK BUILDING 18' x28'
"C" - CONCRETE OIL STORAGE BUILDING 19' x30' x19' HIGH

The Water Cooling Tank building is merely covering for the tanks. The structure is of wood with a monitor roof, the top of which is 15 feet above ground. The Oil Storage building is heavy concrete with a flat roof, sometimes covered with earth.

The top stereogram of Jaluit shows a Power Plant Group on the left, and a concrete Communications Center on the right, which contains its own power plant.

FAR LEFT: Two revetted wooden power plant buildings in the Aleutians.

"A" - NORTHERN POWER PLANT 35' x55'
"B" - SOUTHERN POWER PLANT 35' x35'
"C" - RADIO STATION

Note oil storage near Northern power plant. This type of power plant is not as typical at the present time as the ones shown above. These are quite vulnerable to bombing attack.

LEFT: Northern power plant reconstructed and enlarged after original was damaged by U. S. bombing.

CONFIDENTIAL

RELATED INSTALLATIONS
MILITARY POWER PLANTS (CONT.)

MALOELAP

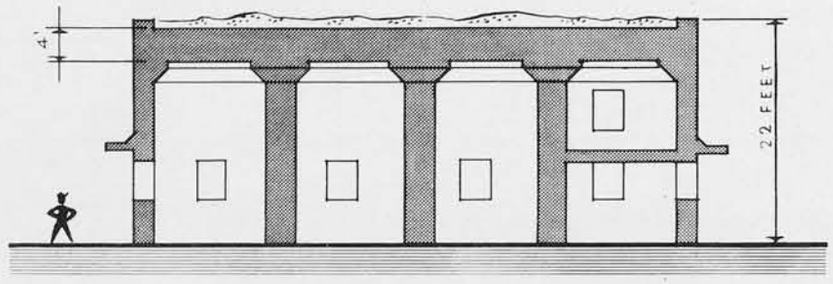
"A" - 48' x55' CONCRETE POWER PLANT
"B" - WATER COOLING TANK BUILDING
"C" - CONCRETE OIL STORAGE BUILDING

DIESEL GENERATOR

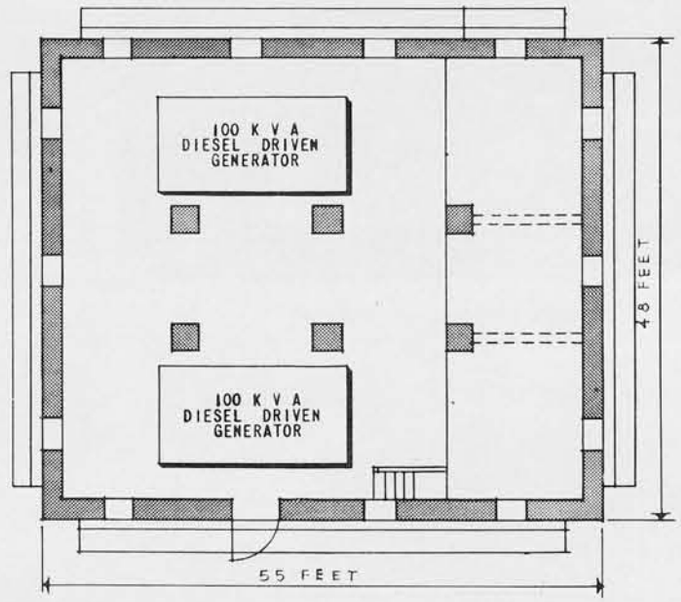
This type of engine (also example below, left) stands about ten feet high when set on its mountings, and thus requires a high ceiling in buildings where installed.

DIESEL GENERATOR

KWAJALEIN



SECTION



CONCRETE POWER PLANT

Standard concrete Power Plant building. The dimensions are 48' x55' x22' high. These structures are very strongly built, having walls 2' thick and roof 4' thick, covered by earth which is filled to the level of the tops of the parapets. Vents are usually visible in roof. Six heavy (4' square) reinforced concrete columns are used to support the roof slab.

There are other types of concrete Military Power Plants in use by the Japanese. However, this design is shown because it has been seen most often up to the present date.

Two examples of large Diesel engines with generators of the type used in Military power plants are shown on this page.

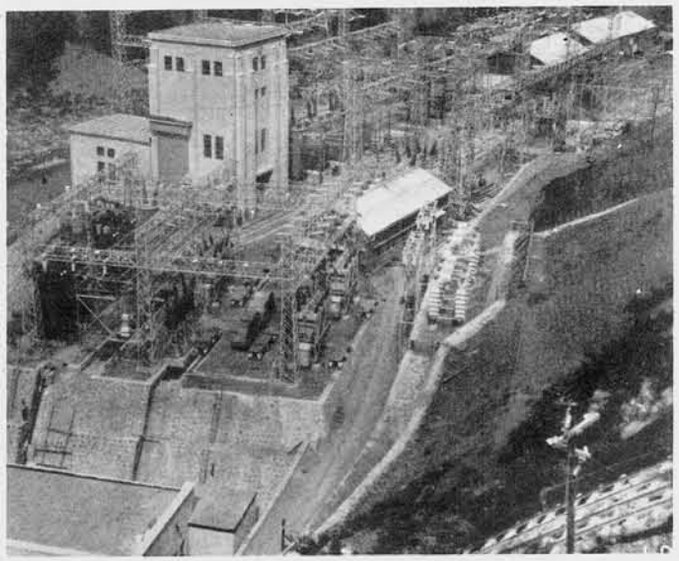
CONFIDENTIAL

RELATED INSTALLATIONS
LARGE POWER STATIONS

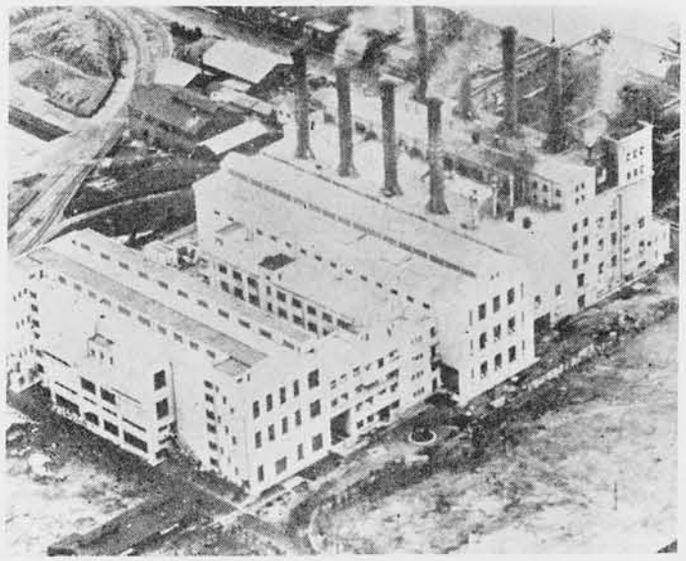
On this page are shown pre-war photos of a few Japanese large scale power stations. These electrification projects are distributed over the Japanese homeland for industry and city power.

Most Japanese power is hydro-electric, which can be easily identified on aerial photos by the penstocks, transformers, and by the large power line towers in the vicinity.

In areas supplied by these stations, individual military power plants, such as are shown in preceeding pages, will not be necessary, and spotting of electronics devices will be more difficult.

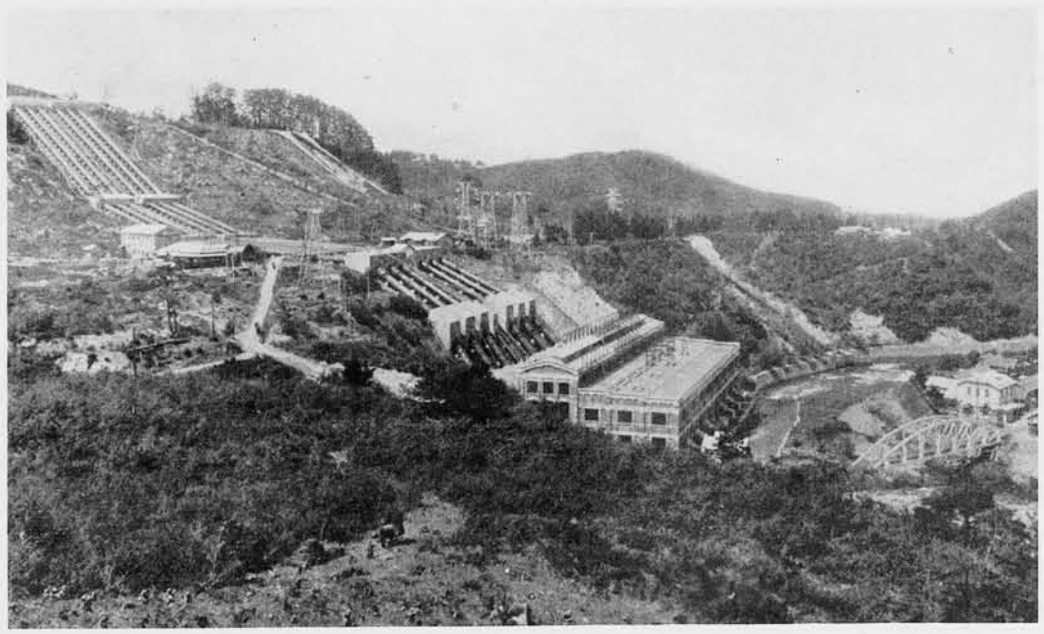


TRANSFORMER ARRAY

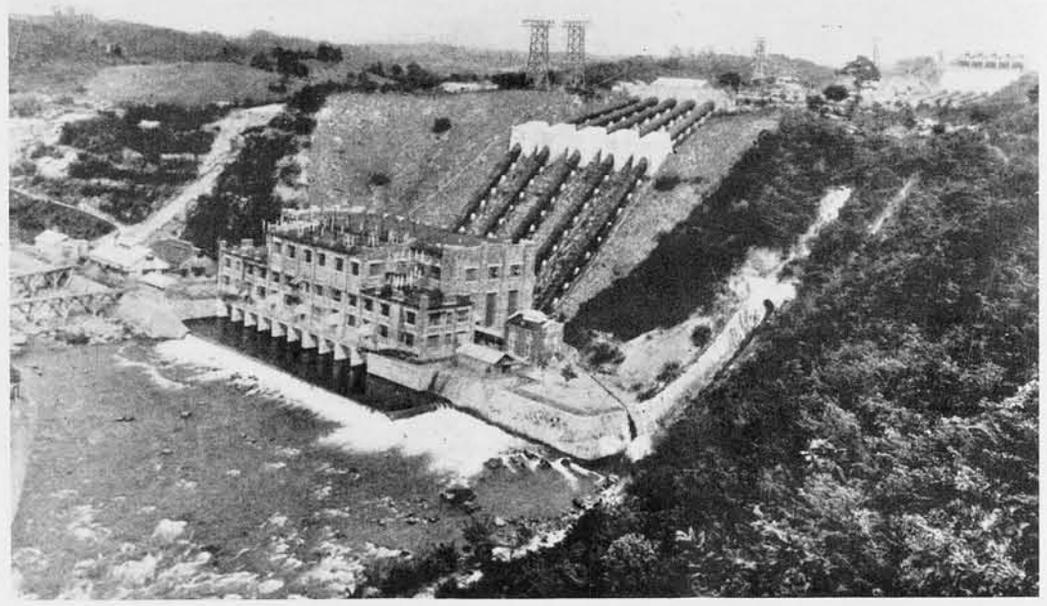


KAWASAKI R.R. POWER STATION

YANAGAWA POWER STATION

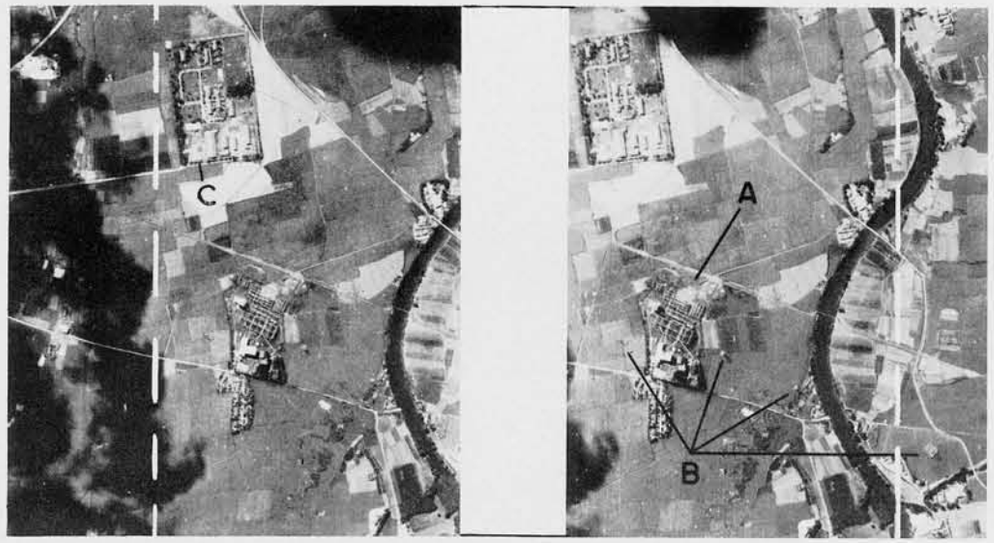


INAWASHIRO STATION NO.1



INAWASHIRO STATION NO. 2

RELATED INSTALLATIONS
TRANSFORMERS

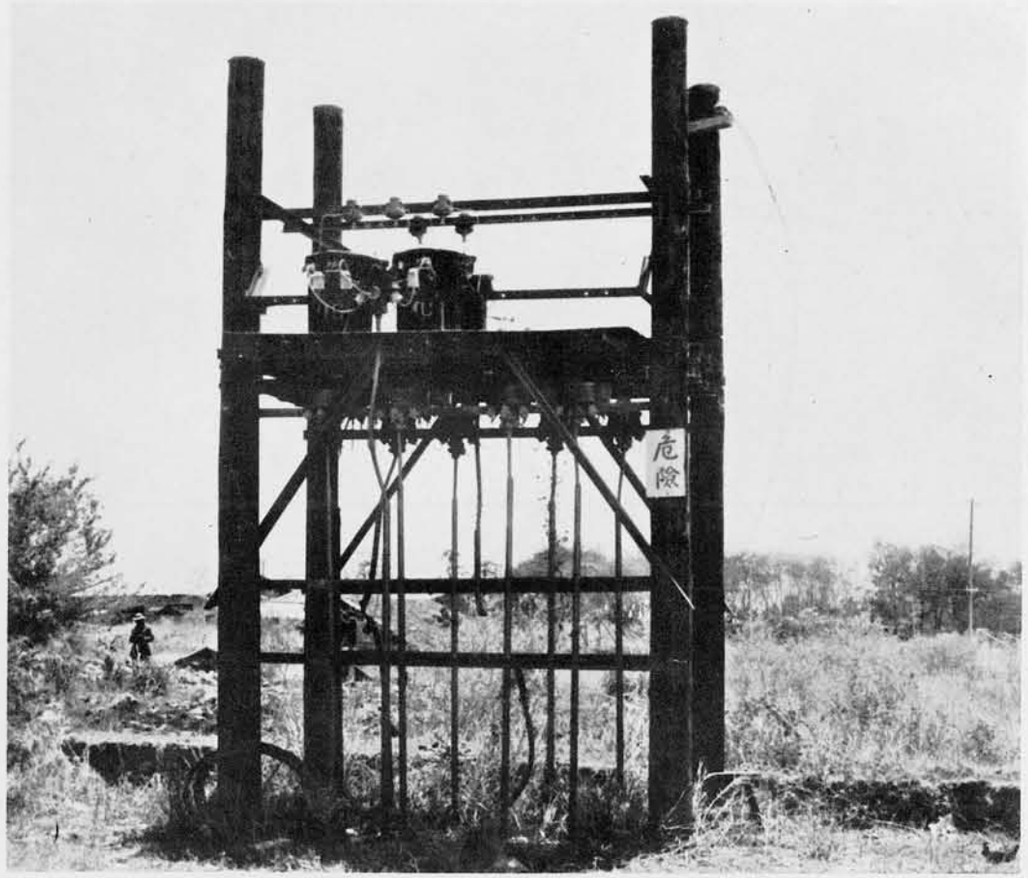


(R.F. - 1/16400)

LARGE TRANSFORMER STATION

Transformer station at Takao, Formosa.
"A" - TRANSFORMERS
"B" - STEEL TOWERS SUPPORTING POWER LINES
Note Radio Station at "C".

MILITARY TRANSFORMER STATION



MILITARY TRANSFORMER STATION

Transformer platform is usually from 12 to 15 feet above ground and is about 8 feet square in vertical view.

MILITARY TRANSFORMER STATION

RELATED INSTALLATIONS
TRANSFORMERS (CONT.)

TELEPHONE CABLE, JAPAN

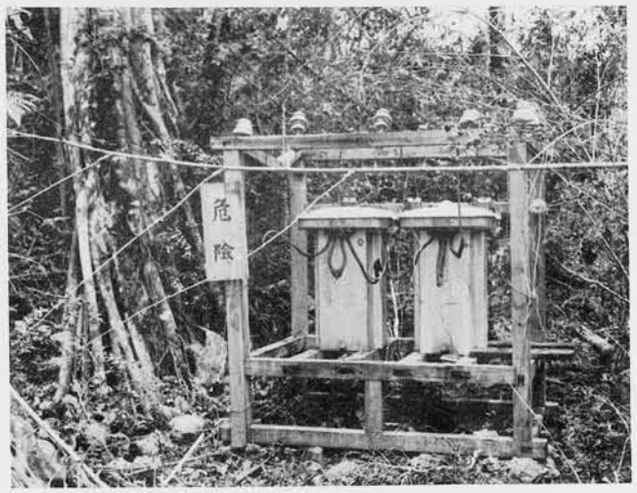
The above two pictures illustrate the method used for supporting central telephone cables in Japan. The loading coils are on heavy steel structures spaced up to 6000 feet apart.

TRANSFORMER

Well-concealed small military transformers at Guam. This sort of practice, not uncommon with Japanese installations, offers a real challenge to the interpreter.

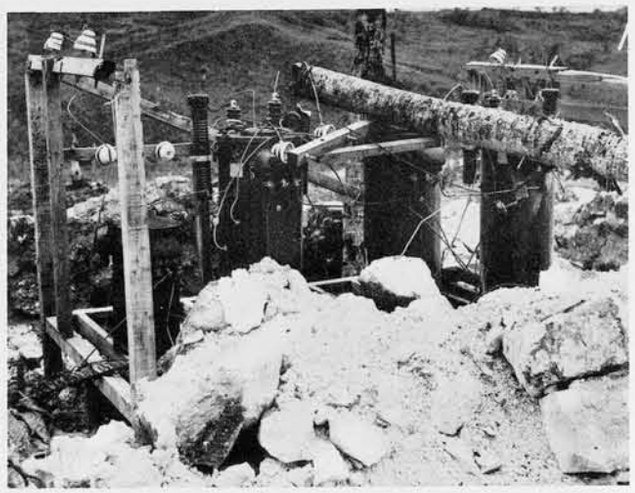
TELEPHONE CABLE. JAPAN

The size and shape of these structures resemble the military transformer stations shown on the previous page. Although such installations may not be vital targets in themselves, they furnish valuable interpretation clues.



TRANSFORMER

Same military transformer on Guam uncovered. Entire installation is about 5 feet square.

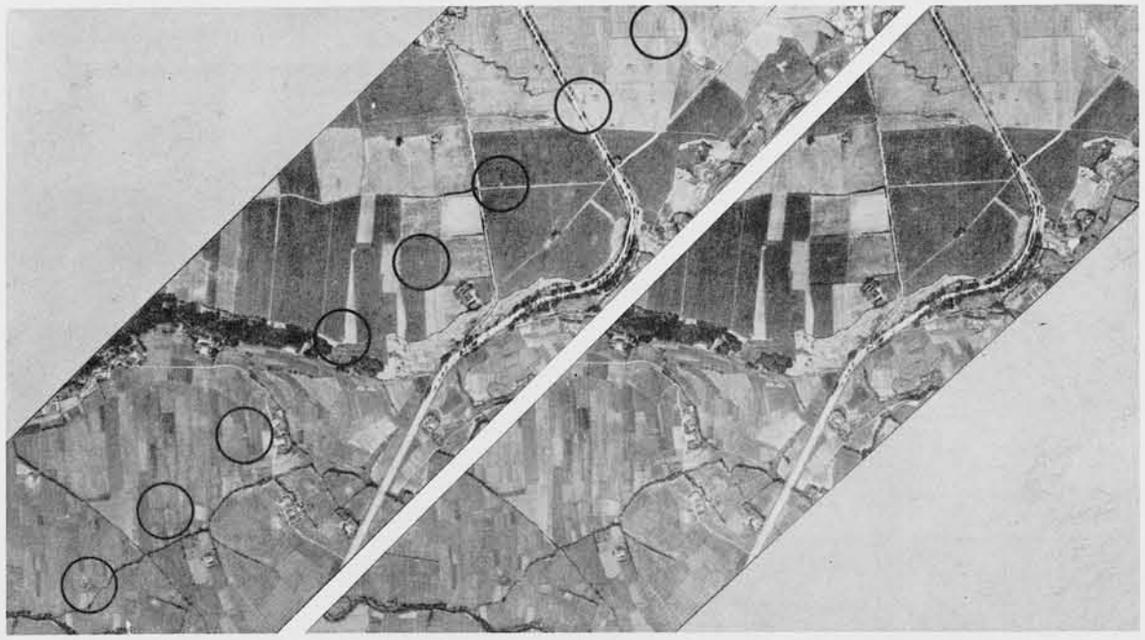


SMALL TRANSFORMER

Transformers for underground power plant - made by a United States company several years ago.

RELATED INSTALLATIONS

TRANSMISSION LINES

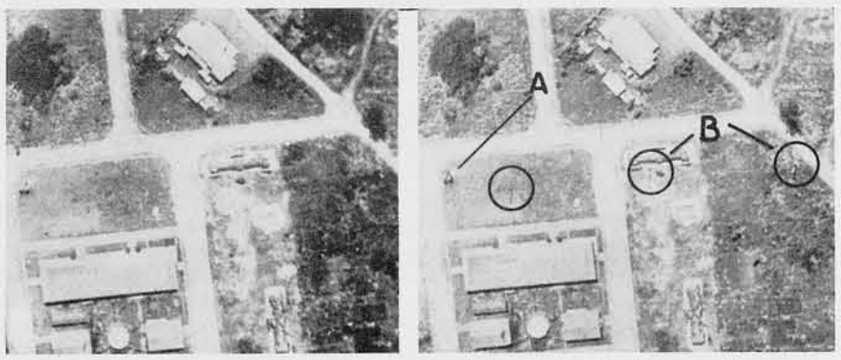


POWER - FORMOSA

High tension lines can be traced across the countryside in this example at Formosa.

POWER AND TELEPHONE POLES - SAIPAN

POWER SAIPAN



POWER SAIPAN

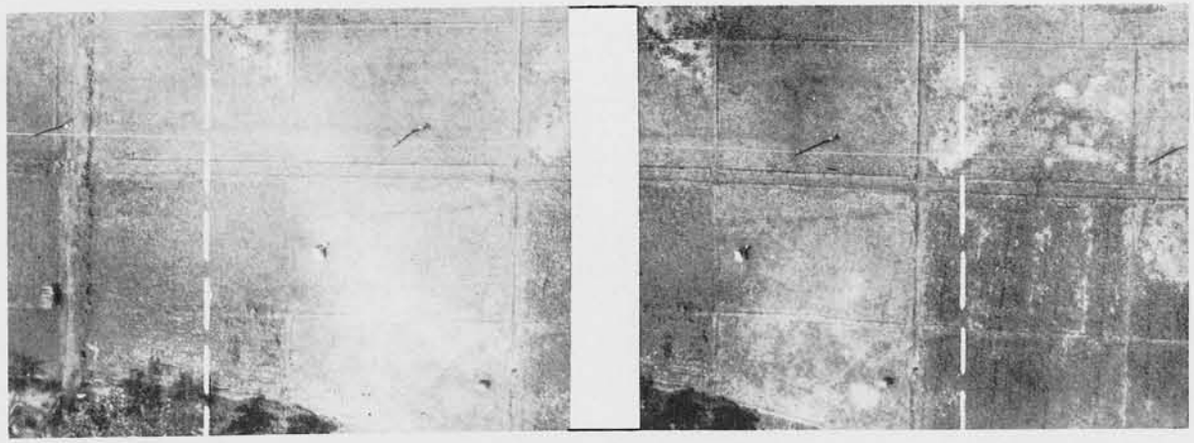
The above two views of transformer station and power line on Saipan offer a good opportunity for reference.

"A" - TRANSFORMER STATION
"B" - POWER LINE POLES

RELATED INSTALLATIONS

TRANSMISSION LINES (CONT.)

Examples are shown on this page of transmission and telephone lines. Steel towers, of the type shown on Java, may sometimes be mistaken for electronics devices such as radio or radar when examined singly, or in a picture of limited coverage.

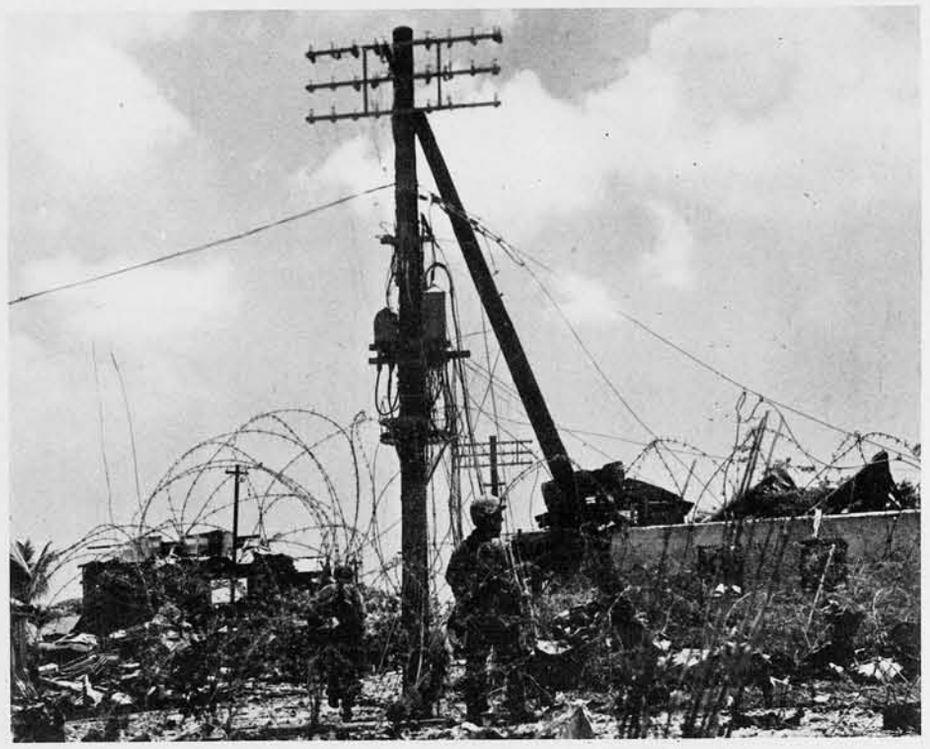


TELEPHONE CABLE, GUAM

POWER LINE · JAVA

POWER OR PIPE LINE SLASH · PALAU

POWER POLES · MANCHURIA



TELEPHONE POLES · SAIPAN

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-7

7.01 — 7.99

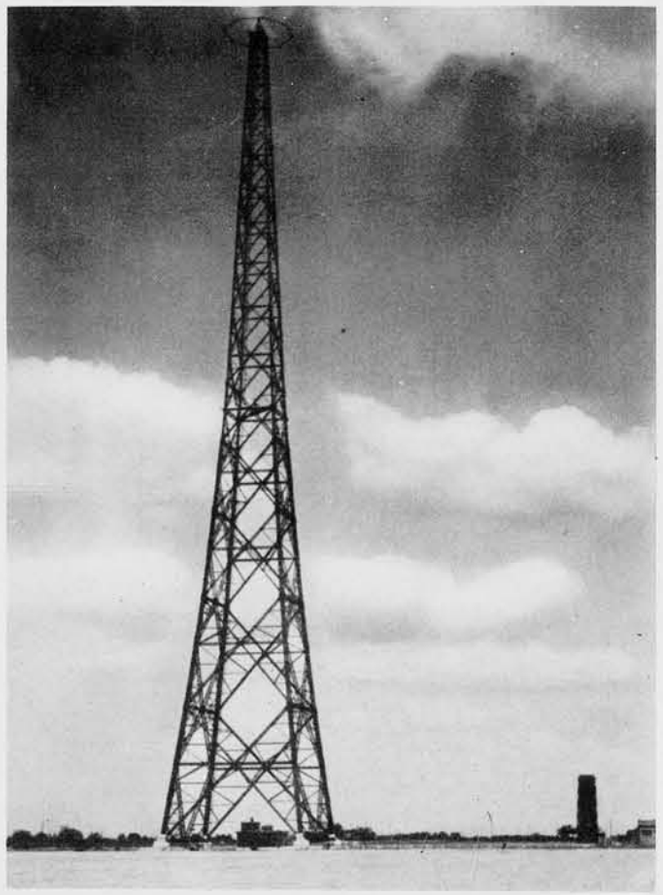
COMPARATIVE STUDIES

COMPARATIVE STUDIES
RADIO MASTS

This section, "Comparative Studies", was prepared as a general treatment of the interpretation of Electronics installations from aerial photographs.

Here are included a few pages illustrating comparisons and contrasts between electronics installations and certain similar appearing non-electronics forms as they show up in aerial photographs.

The first three pages are devoted to studies of radio masts of both Oriental and Occidental design.



GERMAN

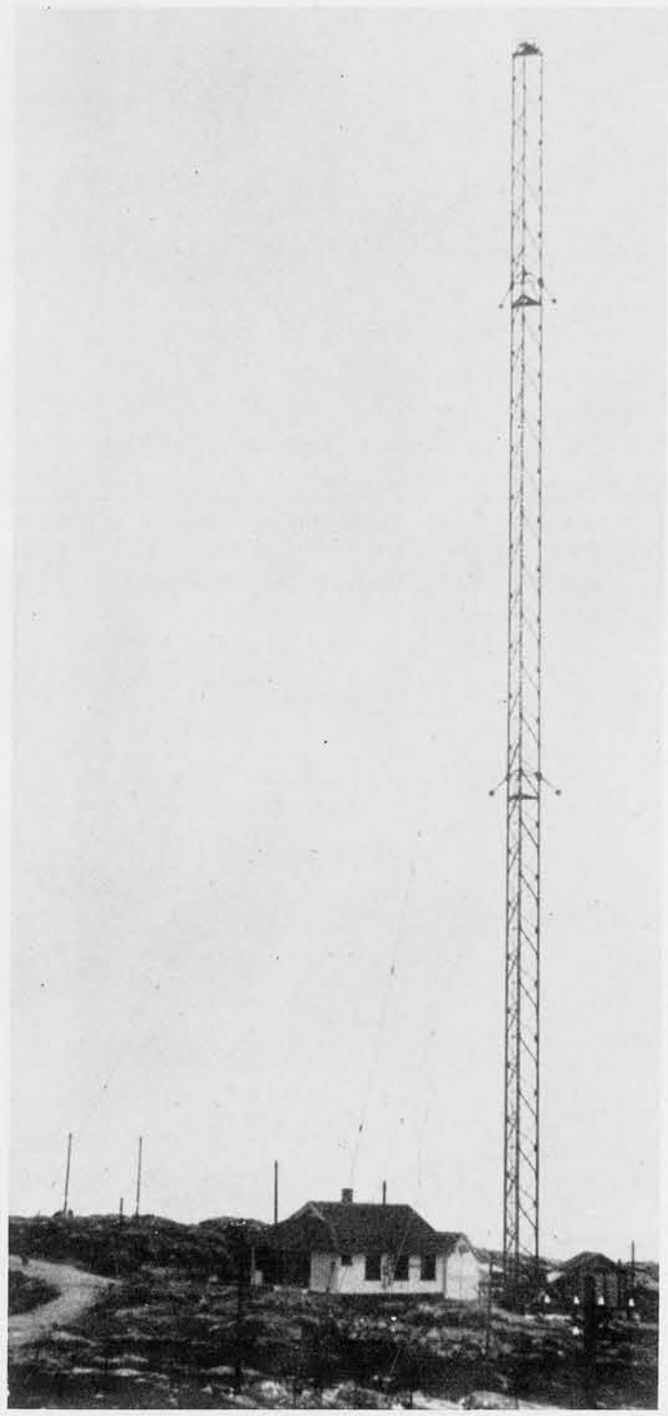
This lattice mast is of German design and is apparently a top loading radiating mast resting on insulators. The steel framework of the tower and the circular form at top transmits radio energy without need for other antennae.

GERMAN

Two radiating masts of German design near Rapopo, New Britain. This was a prewar broadcast station. Note D.F. type towers nearby.

FRENCH

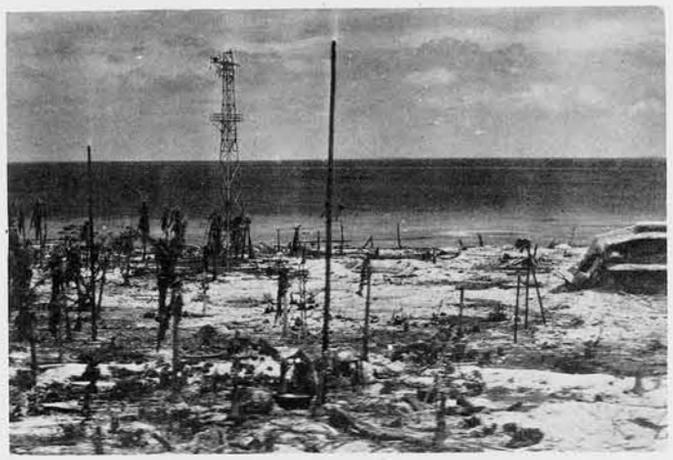
Mast of pre-war "Radio Normandie" broadcast station - Louvelat. Masts of this type, as well as others on this page, are seldom built by the military.



NORWEGIAN

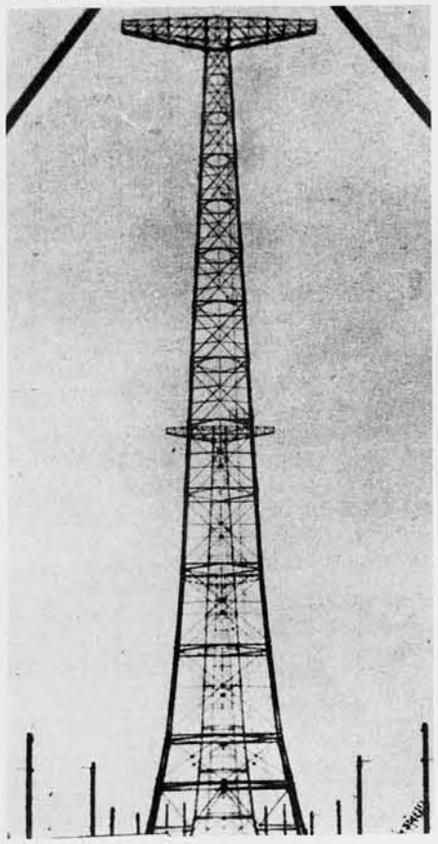
Norwegian mast similar in design to those at Rapopo. This is a pre-war construction, also. All masts on this page are used with medium to low frequency communications.

COMPARATIVE STUDIES
RADIO MASTS



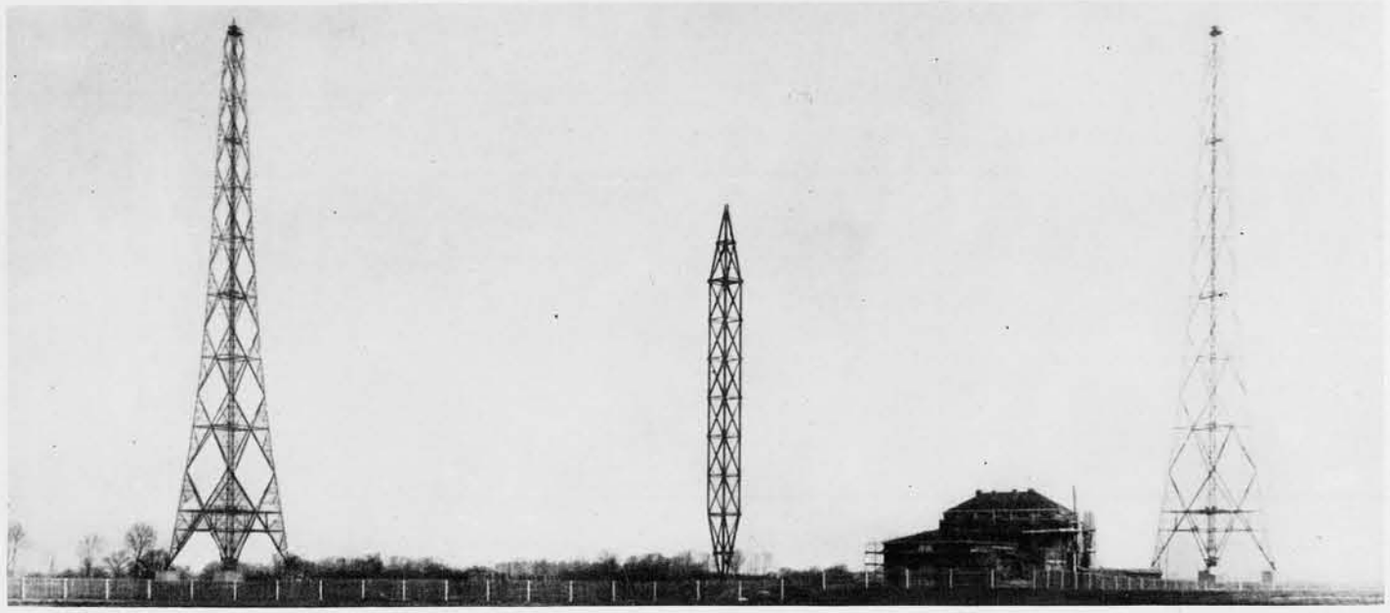
JAPANESE MILITARY STATION

When low wood stick masts are found in close proximity to steel lattice masts, the former probably carry antennae for transmission at higher frequencies.



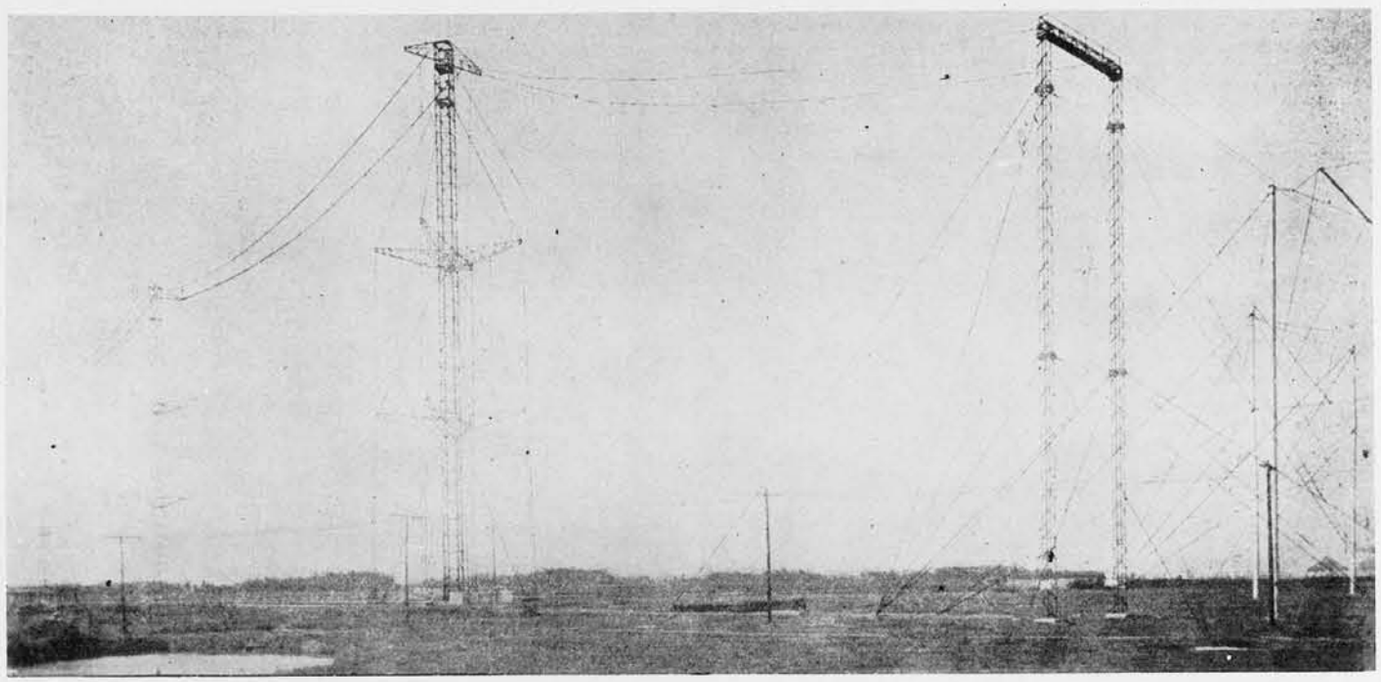
MANCHURIAN

Steel lattice masts of Japanese controlled low frequency station in Manchuria. This station was erected before the war.



GERMAN

Police radio station of pre-war design in Munich. These stations are probably of lower frequency than those commonly used by the German military in this war.

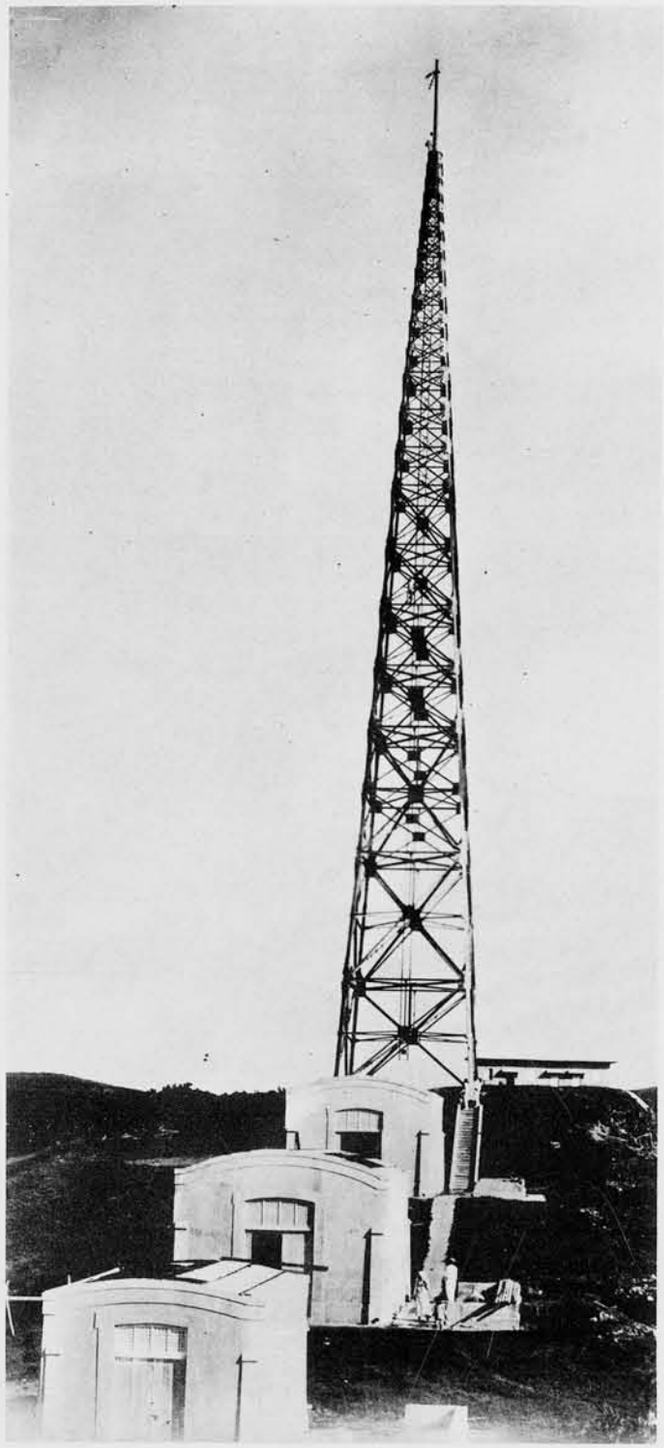


CHINESE

Complex array of antennae and masts used by the pre-war Chinese Government station at Shanghai, called the "Chenju" station. Masts similar to those at left (above) are sometimes used by the Germans for communications.

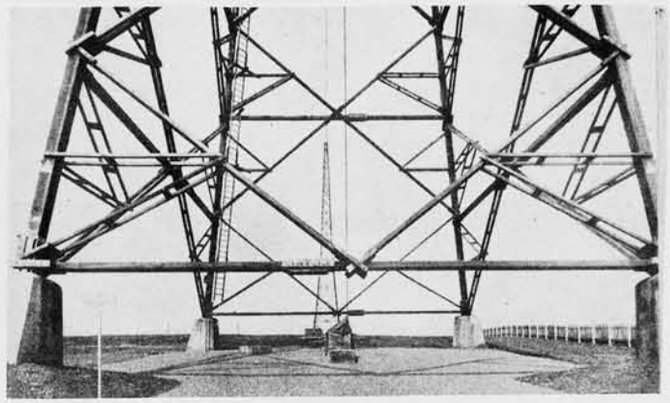
COMPARATIVE STUDIES

RADIO MASTS (CONT.)



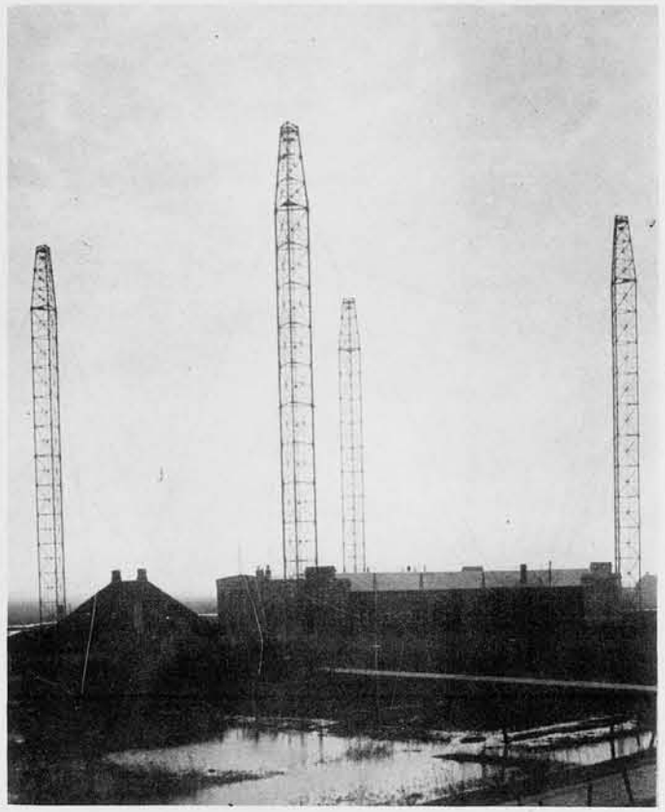
UNITED STATES

Old steel lattice mast at Santo Domingo de Basco. Picture was taken in 1928.



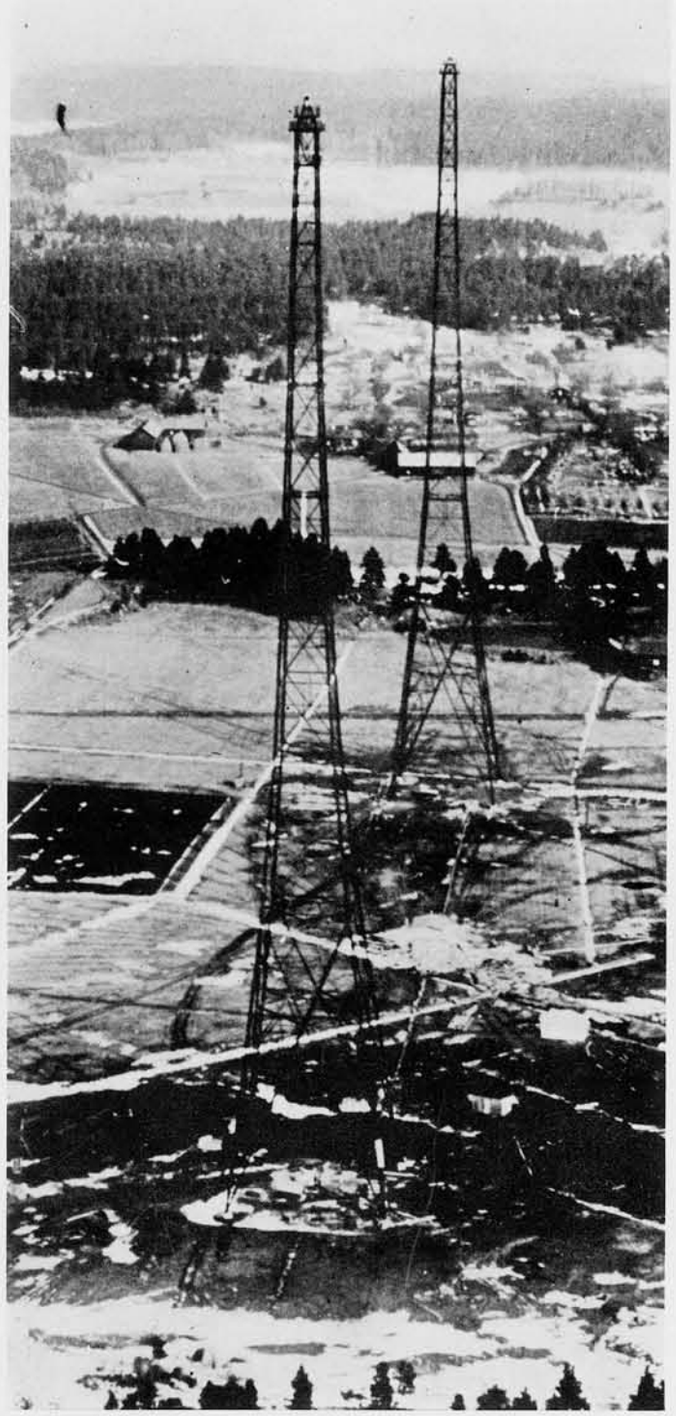
GERMAN

Broadcast station at Wurttemberg, built during 1920's. Bases of masts are made of wood.



GERMAN

Ship to shore station located in Germany. This station undoubtedly has long range and may have navigational aid capacities.

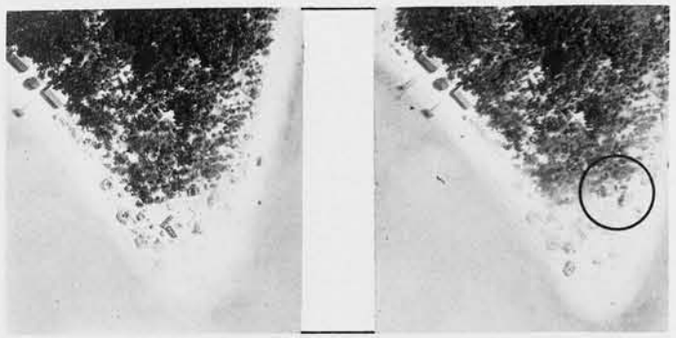


SWEDEN

Steel lattice masts of Stockholm Radio Station. Note radiating pattern of buried cable emanating from transmitter house. Patterns of this type indicate a ground mat or the presence of tuning houses.

COMPARATIVE STUDIES

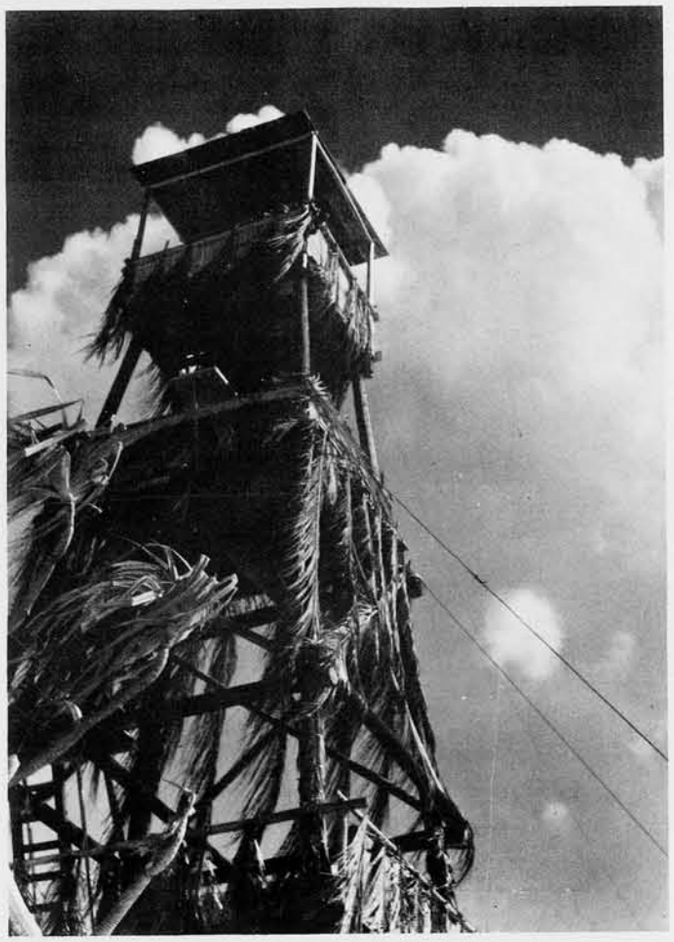
OBSERVATION TOWERS



(R.F. - 1/6700)

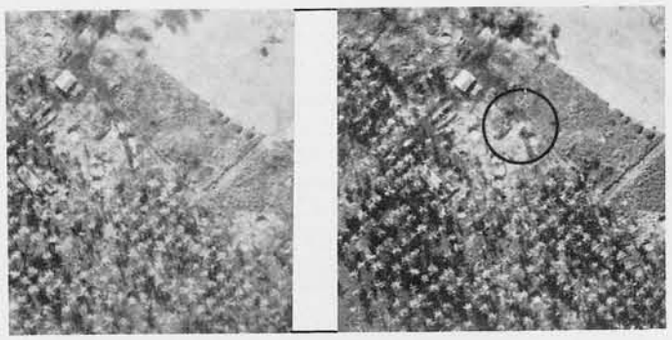
TARAWA

Wooden observation tower at Tarawa. Such towers are necessary on low coral islands for lookouts and for artillery observation.



TARAWA

Same tower at Tarawa, which was used with coast defense guns. Note telephone wires and palm frond camouflage.



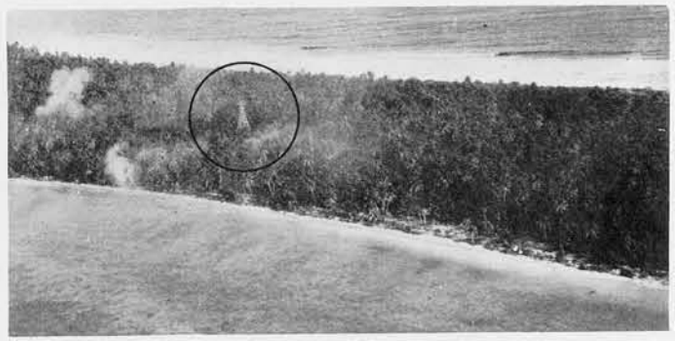
(R.F. - 1/5500)

TOBERA

Wooden observation towers are usually between 40 and 60 feet in height.

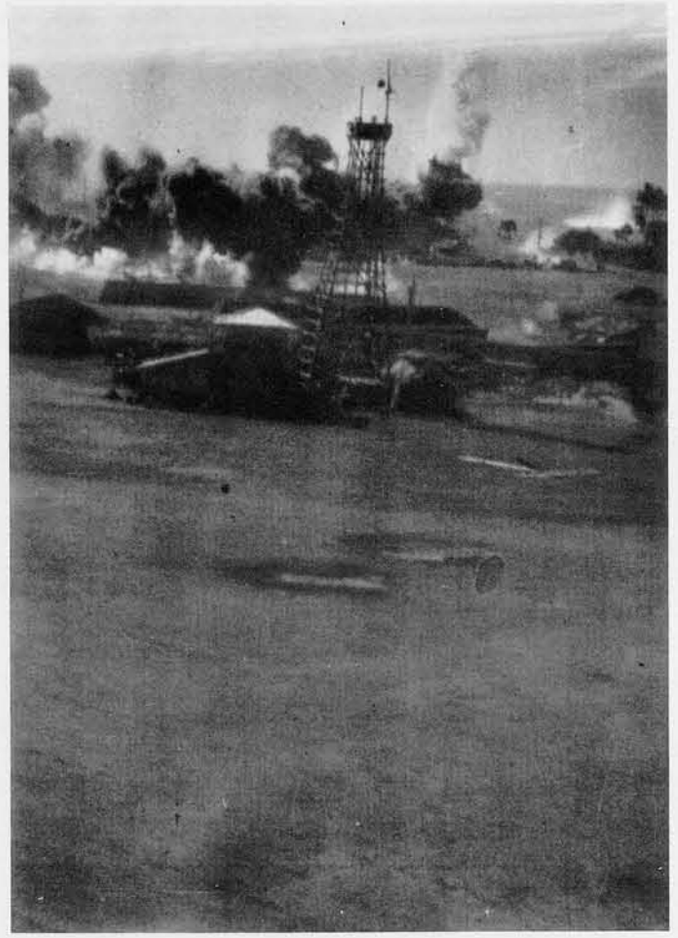
GUAM

Observation tower near Orote Airfield. Note palm frond camouflage and presence of communications lines. Sometimes observation towers near airfields are used as control towers. However, the platform is usually covered and will contain high frequency radio communication in such cases.



UTIRIK

Countless styles of design are found in Japanese observation towers, yet most reflect a nationalistic flavor in arrangement of architectural forms.

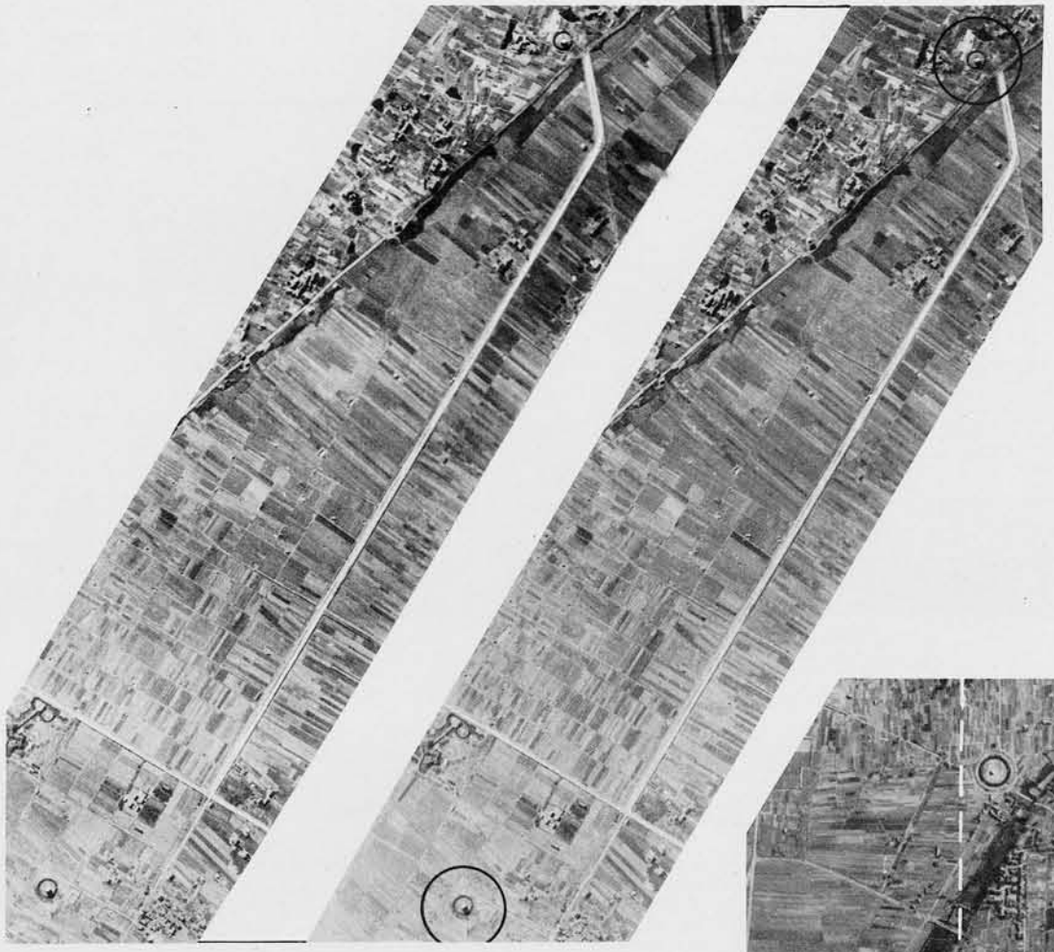


MALOELAP

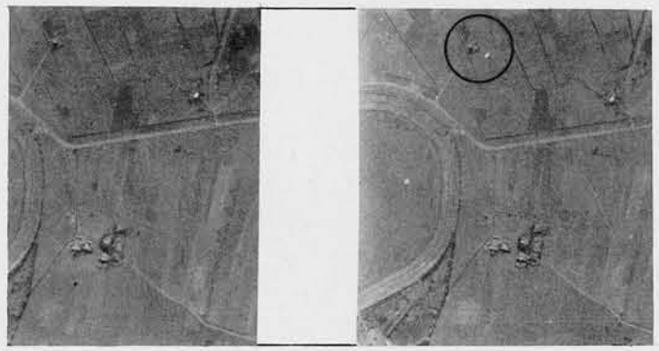
The structural members of a wooden observation tower are likely to give a more horizontal effect than a steel lattice mast. Steel structural members are seldom bent in this manner.

COMPARATIVE STUDIES

DIRECTION FINDERS

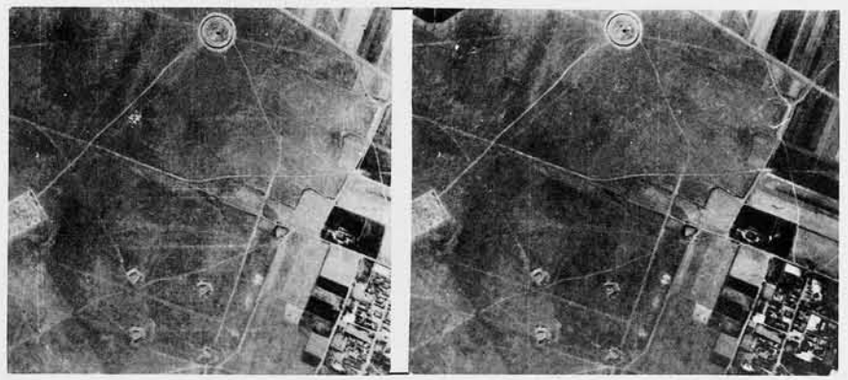


HANKOW (R.F. - 1/17000)



HANKOW

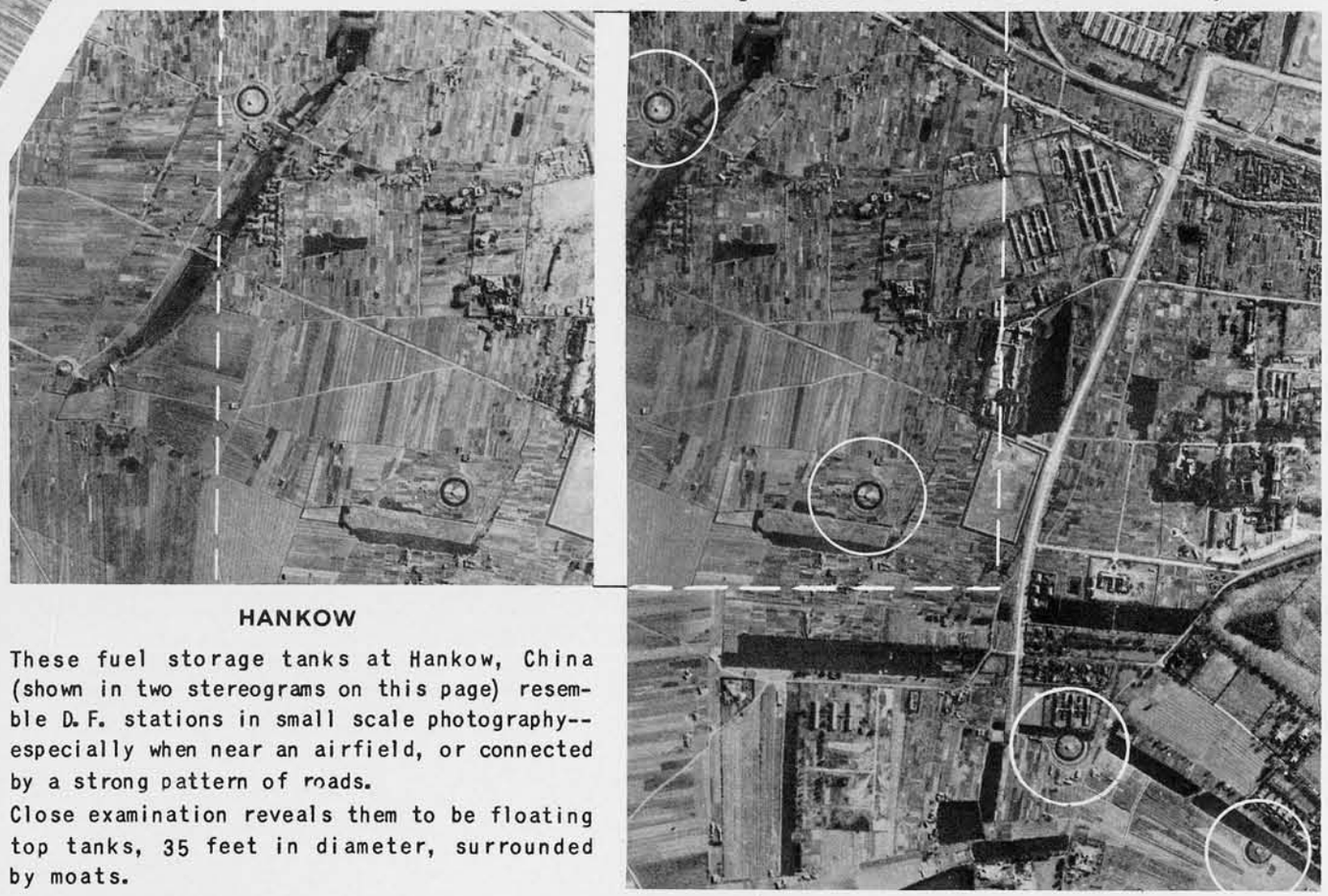
D. F. tower at end of runway surrounded by a square enclosure which is mindful of the German method. D. F. is nearly always present near airfields and each installation is reached by a road or path connection.



YUNCHENG

This installation at Yuncheng is probably a high frequency D. F. tower surrounded by a circular levee for protection against flood. Note small auxiliary buildings within levee. Compare this with fuel tanks at Hankow.

General: There are many comparatively innocent objects that may be confused with vital electronics installations as well as countless camouflage methods and even illusions created by chance.

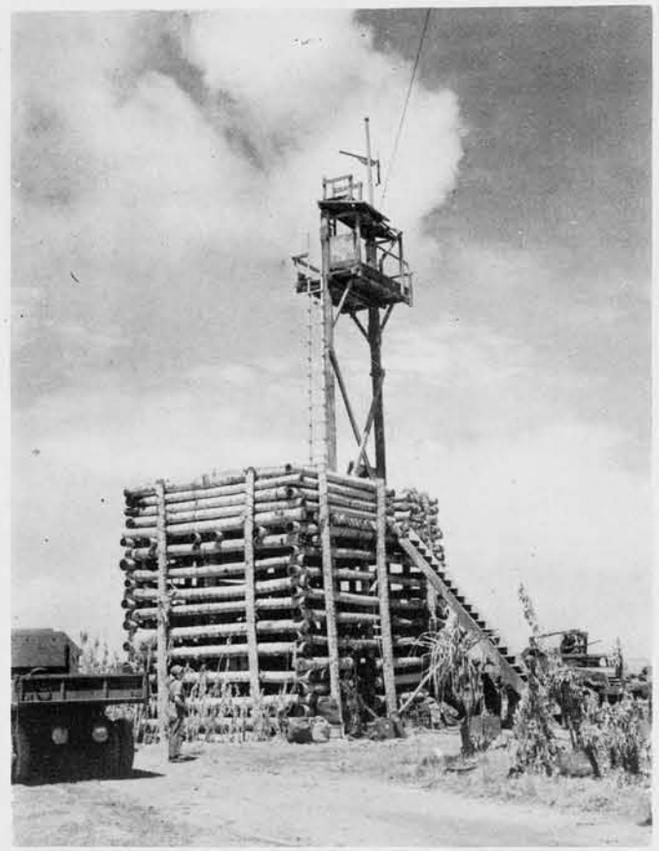


HANKOW

These fuel storage tanks at Hankow, China (shown in two stereograms on this page) resemble D. F. stations in small scale photography--especially when near an airfield, or connected by a strong pattern of roads.

Close examination reveals them to be floating top tanks, 35 feet in diameter, surrounded by moats.

COMPARATIVE STUDIES
SIGNAL TOWERS



MAKIN

ABOVE:

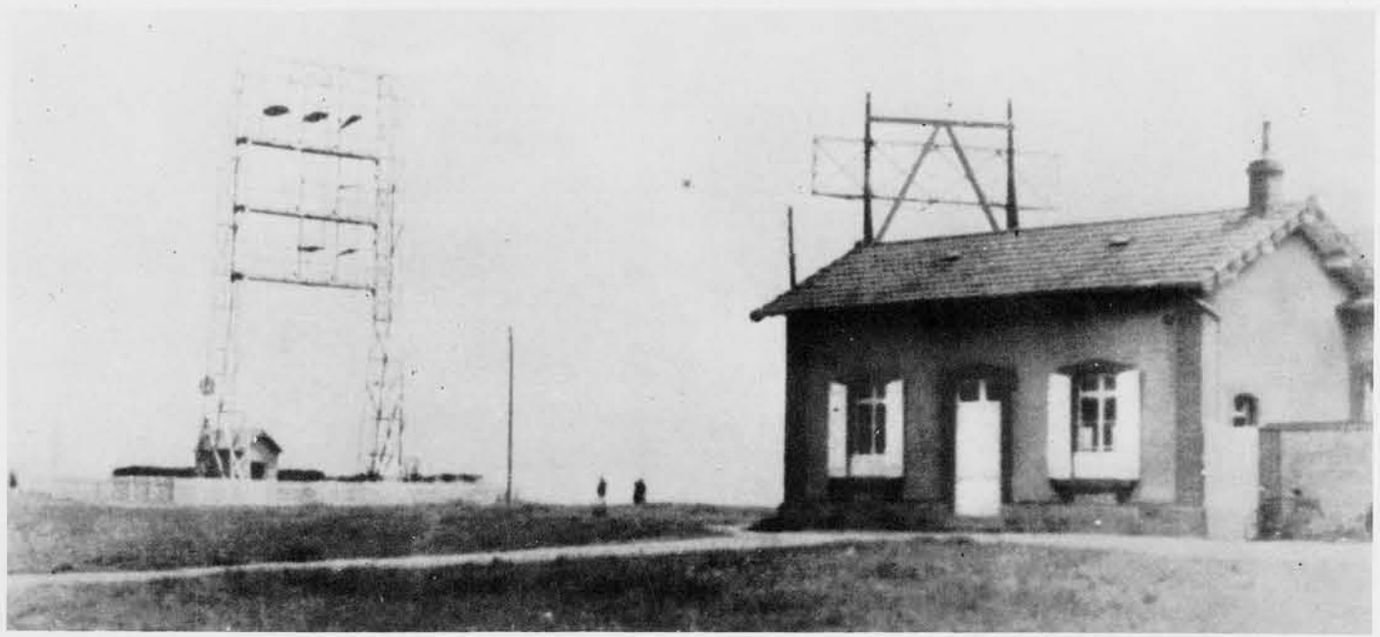
Japanese signal tower at Makin, Gilberts. This base is constructed of coconut logs, lashed together at the corners. Upper portion is braced with guy wires. Note communications line. Tower is approximately 50 feet above ground.

RIGHT:

Although not properly classified as a "Signal Tower", these are shown here for reference. It is thought that this type of tower is used in connection with port direction.

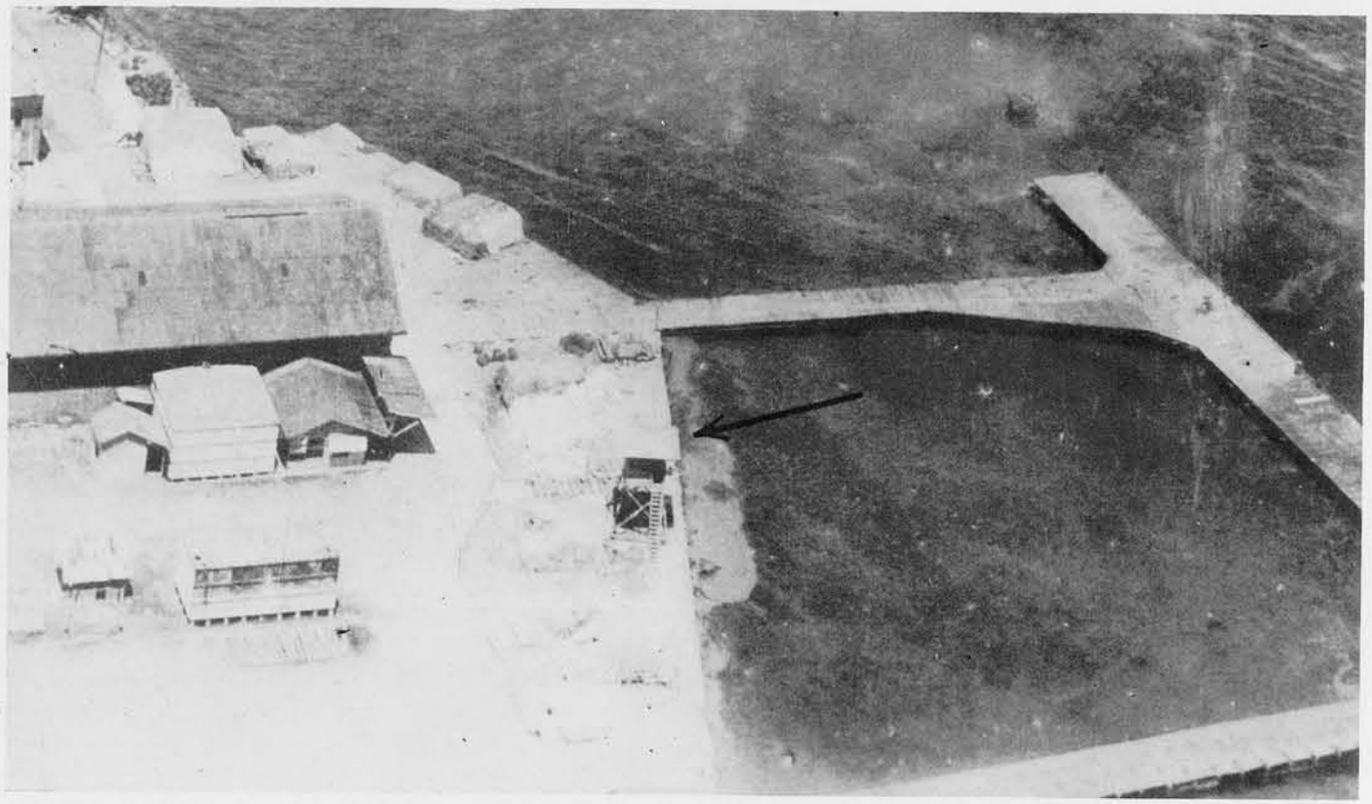
Signal towers, observation towers, as well as many electronics buildings often vary in design because of the whims of local commanders, local builders, and emergency needs - despite the fact that the Japanese military have standard designs for most structures. Even an improvised radar antenna has been found.

This is in contrast to the orderly Germans, whose installations vary from a few standard types but little, and then usually only in dimension.

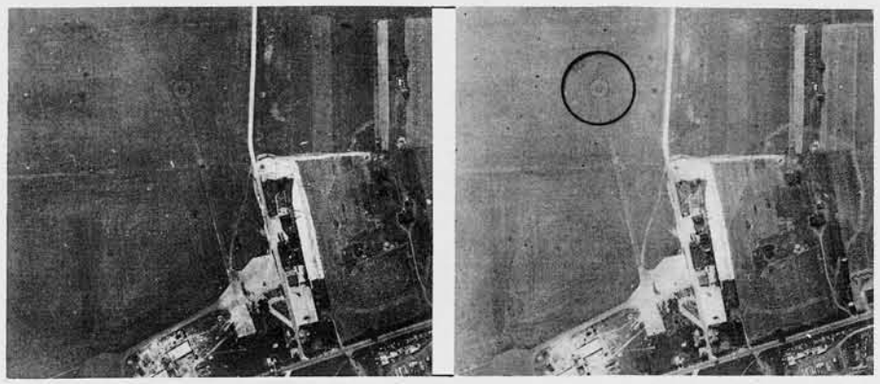


FRANCE

Signal station and semaphore situated near the ocean.

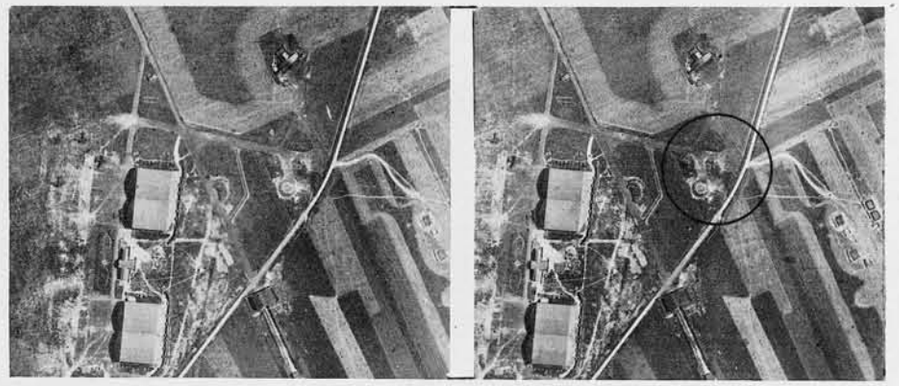


RABAUL, NEW BRITAIN



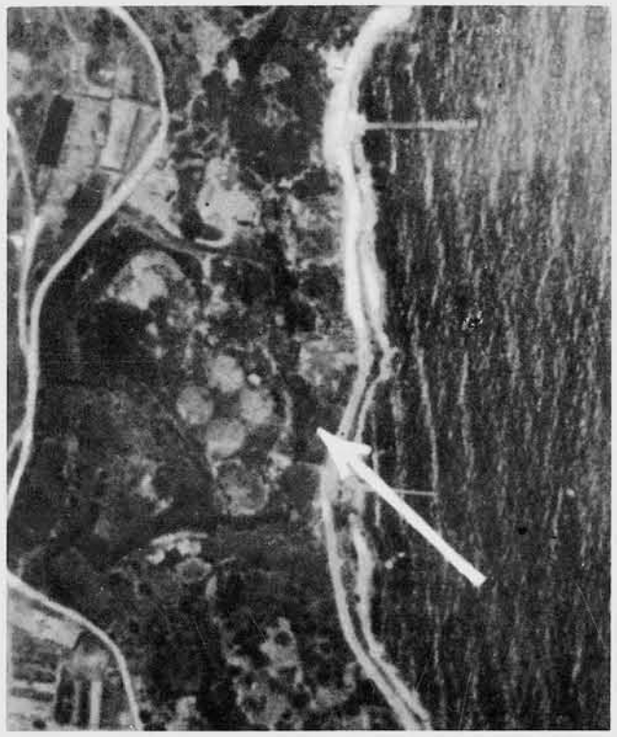
GERMAN COMPASS SWINGING BASE (R.F. - 1/8300)

Most German airfields contain circular patterns connected to a runway spur, which are "compass swinging bases." These are used for checking and setting the plane's compass before taking off on a mission.



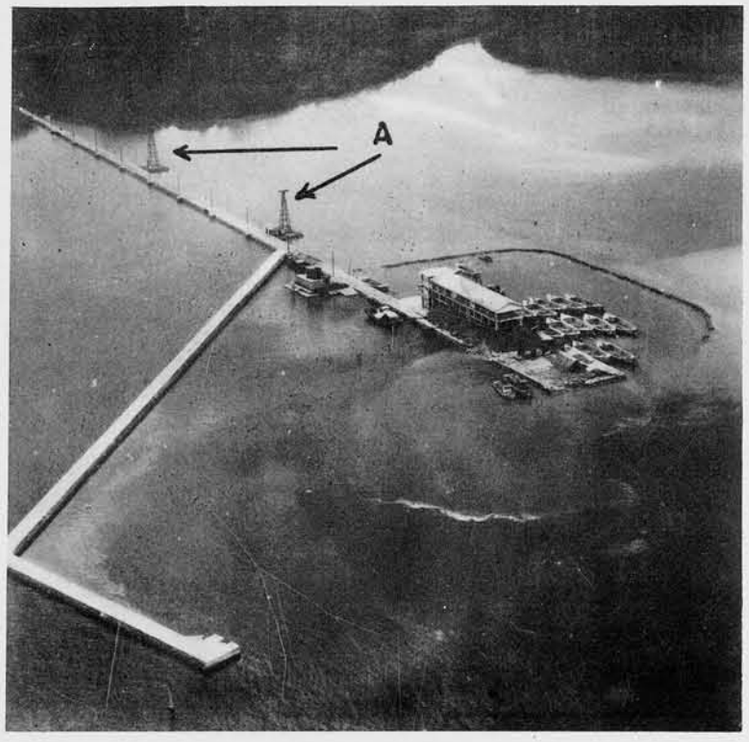
GERMAN COMPASS SWINGING BASE (R.F. - 1/8000)

Another German "compass swinging base" (possibly two). Such installations have not been observed on Japanese airfields to date, as far as is known.



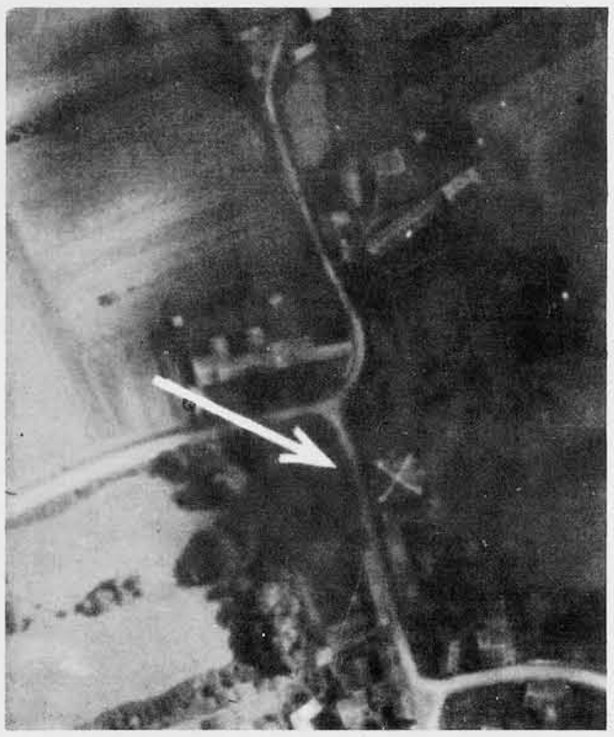
BURIED FUEL TANKS

Buried fuel tanks may look like German type medium frequency Adcock D.F., as can be seen from above photograph.



CABLE CAR TOWERS

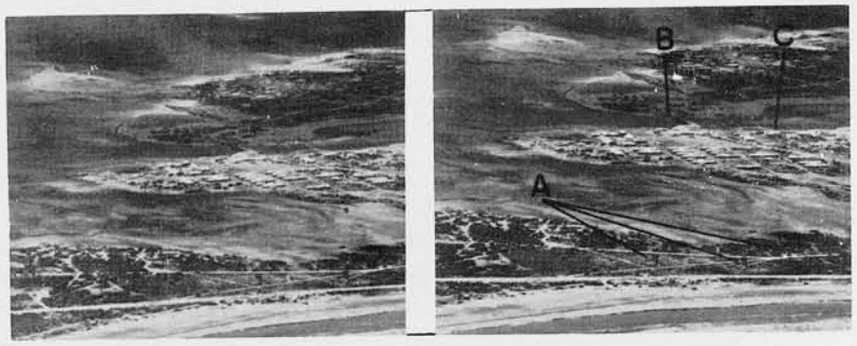
Occasionally, steel towers may be mistaken for radio masts. In this view are two towers which support a cable car used in connection with certain types of industry. This tower design, however, is slightly different from Japanese standard types of radio masts.



DECOY D.F.

What appears to be an Adcock D.F. is actually light-toned ridgelines on the roof of a building in German-held territory.

COMPARATIVE STUDIES
MISCELLANEOUS



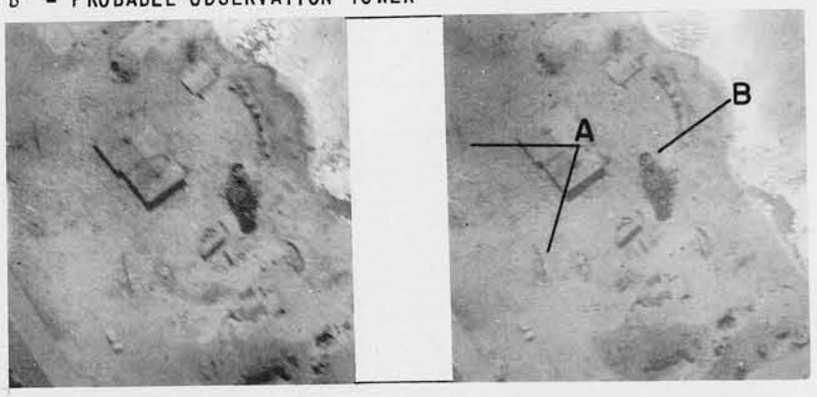
WAKE

in this stereo-oblique are three types of towers used for entirely different purposes.

"A" - HIGH FREQUENCY D.F.

"B" - PROBABLE OBSERVATION TOWER

"C" - WATER TOWER

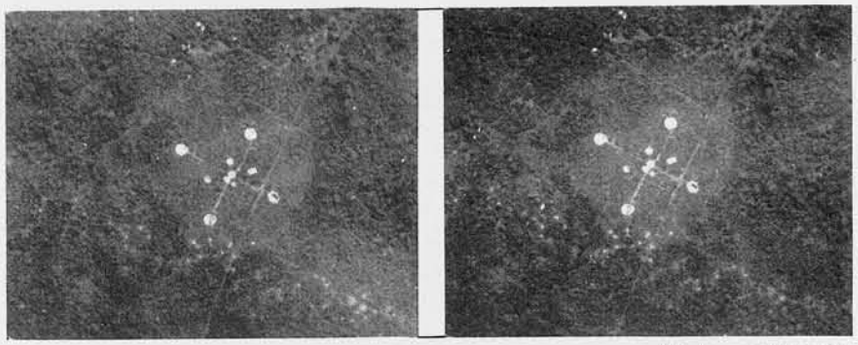


WAKE

Vertical stereogram of a portion of the same area as stereo-oblique shown above.

"A" - TELEPHONE LINE

"B" - PROBABLE OBSERVATION TOWER

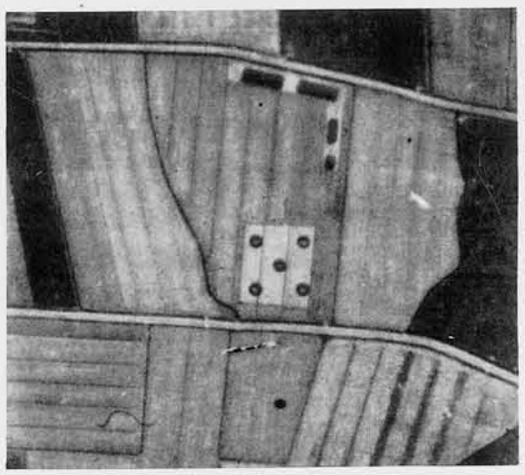


AA BATTERY (R.F. - 1/6000±)

The above pattern, first suggestive of a medium frequency Adcock D.F., is either a new medium AA battery or a decoy. Photograph was taken over Japanese-held territory.

WATER PURIFICATION (R.F. - 1/10400)

This arrangement of forms in Takao, Formosa, indicates a water purification process. The circular form contains the type of geometry often found in electronics installations.

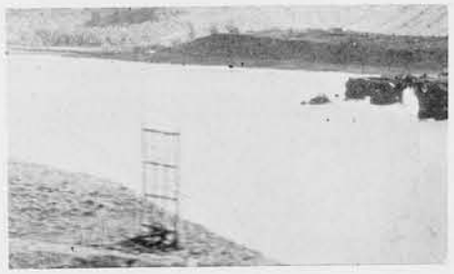


DECOY AA

DOMESTIC PATTERN (R.F.-1/3500)

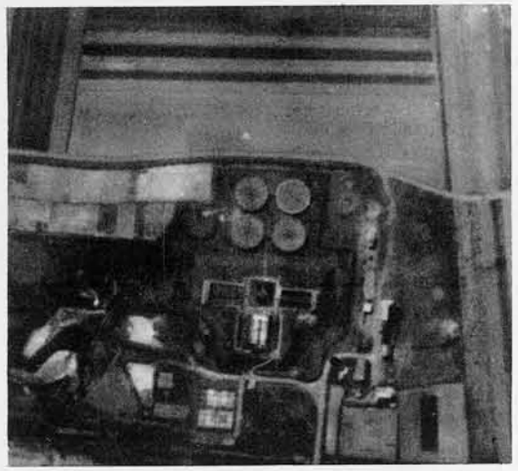
The circular forms (above) are probably the result of using primitive sugar cane processing apparatus.

LEFT: Compare this decoy AA position (German battery) with Japanese AA position on this page. Both may be confused with electronics.



PROBABLE DUMMY RADAR

RIGHT: Sewage plants, at small scale may often appear to be electronics installations. Surrounding buildings and activities usually prevent such an error in identification, however.



SEWAGE PLANT

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

PUBLICATIONS PREPARED AND AVAILABLE
AT U. S. NAVAL PHOTOGRAPHIC INTELLIGENCE CENTER

● JAPANESE PILLBOXES	FEB. 1944
● JAPANESE SEARCHLIGHTS	FEB. 1944
● JAPANESE AA CD WEAPONS	FEB. 1944
● BARRICADES	APRIL 1944
JAPANESE CAMOUFLAGE	MAY 1944
JAPANESE AIRCRAFT SHELTERS	MAY 1944
JAPANESE SUPPLY DUMPS	JUNE 1944
DETERMINATION OF SHIPS' SPEEDS FROM AERIAL PHOTOGRAPHS	OCT. 1944
JAPANESE LANDING CRAFT	OCT. 1944
UNDERWATER DEPTH DETERMINATION	OCT. 1944
JAPANESE ELECTRONICS	JAN. 1945
JAPANESE MILITARY BUILDINGS	JAN. 1945

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BEACH INTERPRETATION
SHIPPING IDENTIFICATION
SHADOW FACTOR TABLES
PHYSIOGRAPHY AND VEGETATION OF THE PACIFIC

PUBLICATIONS PREPARED JOINTLY BY PHOTOGRAPHIC INTELLIGENCE CENTER AND OFFICE OF ASSISTANT CHIEF OF AIR STAFF, INTELLIGENCE, U. S. A. A. F.

● PHOTOGRAPHIC INTERPRETATION HANDBOOK	APRIL 1944
THE PETROLEUM INDUSTRY	JULY 1944
THE COKE, IRON, AND STEEL INDUSTRIES	SEPT. 1944

PUBLICATIONS UNDER JOINT PREPARATION BY PHOTOGRAPHIC INTELLIGENCE CENTER AND OFFICE OF ASSISTANT CHIEF OF AIR STAFF, INTELLIGENCE, U.S.A.A.F.

THE ALUMINUM INDUSTRY
THE AIRCRAFT INDUSTRY
THE COPPER INDUSTRY
THE LEAD AND ZINC INDUSTRIES
THE MAGNESIUM INDUSTRY
THE MUNITIONS INDUSTRY
THE POWER AND GAS INDUSTRIES
THE SHIPBUILDING INDUSTRY
THE SUGAR AND ALCOHOL INDUSTRIES

● pending revision

[redacted]

SECTION-8

8.01 — 8.99

SEARCHLIGHTS

SEARCHLIGHTS
INDEX

SEARCHLIGHTS

INTRODUCTION

A well coordinated system of anti-aircraft defense includes searchlight positions for use in night fire. In order to properly direct visual gun fire on a swiftly moving target, the fire control director must be provided with certain data necessary for computation of future target positions. To obtain this data the target must be illuminated by searchlights.

Searchlight equipment generally consists of the following four major elements:

1. Searchlight
2. Detector (Sound Locator or Radar)
3. Comparator (Director)
4. Power Plant

SEARCHLIGHT:

Military searchlights employ the high-intensity arc in which the source of light is a ball of luminous gas positioned in a crater of positive carbon. High intrinsic brilliancy is derived from the temperature to which the gases are raised by the passage of current through the arc. The maximum beam candle power of a light is dependent upon the diameter of its reflector (parabolic). The larger the diameter the greater is the range and finding power. The extended hand control is a bar about 10' long attached to the searchlight for manual control in the event of failure of the electrical control system or in the absence of one. The purpose of the length of the bar is to place the operating observer at a maximum practical distance from the searchlight in order to decrease obscurity caused by closeness of the beam.

DETECTOR:

In order to determine the point in space to which the searchlight beam is to be directed, the position of the target is determined by means of a detector. The angular displacement of the searchlight may be controlled directly from the detector. However, for tactical reasons (freedom to utilize the detector to search for and detect a new target once a target is illuminated) it is desirable to control the searchlight from a comparator.

COMPARATOR (DIRECTOR):

An electrical, remote control instrument which is used to control the searchlight. The target is usually engaged from bearings supplied by the detector. Once the target is illuminated the comparator operator, by peering through the binoculars, keeps the target in the beam by manipulation of the right and left side azimuth and elevation handwheels.

POWER PLANT OR GENERATOR:

A source of electrical energy necessary for the operation of the searchlight.

GENERAL FUNCTION OF SEARCHLIGHT EQUIPMENT

Identification of searchlights is based primarily upon the revetments or structures for the light and detector; secondarily, the characteristics of the light itself will be proof of correct identity.

Mobile or fixed Japanese searchlights are emplaced in the following types of revetments:

1. Circular Revetments, at grade or excavated.

2. Double-Wall Revetments.

Revetments containing mobile lights will have an opening large enough to provide egress.

Fixed Japanese searchlights are mounted upon the following types of structures:

1. Raised Circular Platforms.

2. Raised Revetments, circular or rectangular.

3. Raised Rectangular Platforms.

A sound locator becomes a distinctive identification feature when emplaced within a saucer-like revetment. The concave surface evidentally increases accoustical efficiency while protection is afforded by the height and thickness of the wall. Revetments with an inside diameter of 35' have been common, and at Rabaul such a revetment was observed to contain a Model 1930 sound locator. Within Japan proper and China, concave revetments 50' to 70' in diameter have been observed to accompany searchlights; such positions may contain the large type of sound locator (or a modification thereof) which was developed previously to the Model 1930.

Radar controlled searchlights were first captured in the Marianas Islands, and to date have not been emplaced in such a way as to be distinctive.

Although differing in size and detail, searchlights are similar in photographic appearance, having a distinctive rounded shape and shadow. Searchlights have been mistaken for AA guns (on aerial photographs), but in comparing their respective bulk, the light appears to be larger and more rounded than an AA gun and its shadow larger than the thin shadow of a gun. Lights are commonly canvas covered for weather protection with the result that such lights often appear practically white in photographic tone.

Searchlights are located about important targets at regular distances, in belts, or in concentrations for intensive coverage. Since searchlights are primarily part of the anti-aircraft defense plan, lights and AA batteries are closely related.

PHOTOGRAPHIC INTERPRETATION

The Japanese do not necessarily employ all four units of equipment mentioned under "General Function". A detector may be used to maintain continuous control of the light in place of a comparator, manual control, or a master light system (see page 8.25). It is possible, but as yet unproven, that searchlight control equipment may be incorporated in the fire control center of an associated gun battery. The source of power may be a community station rather than a generator used exclusively for the searchlight. Such deviations as mentioned above, plus the occasional housing of light and generator in one structure, reduce the number of units that appear photographically. Units of the searchlight set-up will be found situated at some distance from each other; if photographs are of good quality, connecting cables or evidence of their burial may sometimes be seen.

The following size (diameter of reflector) searchlights have been captured from the Japanese.

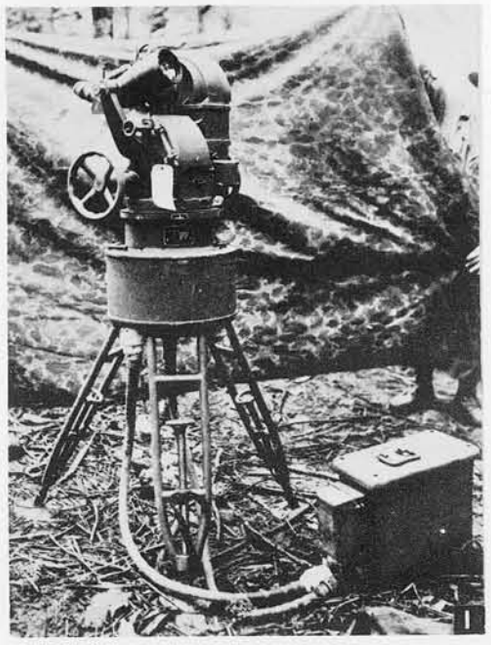
60 cm (23.6")	100 cm (39.4")
75 cm (29.5")	110 cm (43.3")
90 cm (35.4")	150 cm (59.1")
98 cm (38.6")	

The 150 cm (59.1" reflector) light has been found to be more common than any other in captured territory. The approximate dimensions of this light are:

Height - 87" Width - 72" Length - 100"

SEARCHLIGHTS

EQUIPMENT, SOUND LOCATOR CONTROL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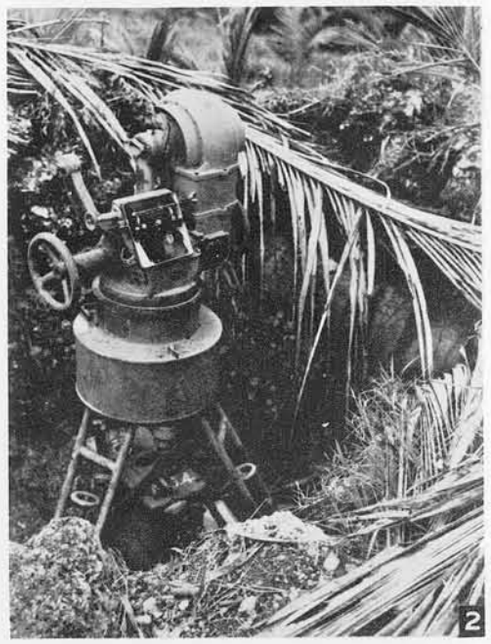
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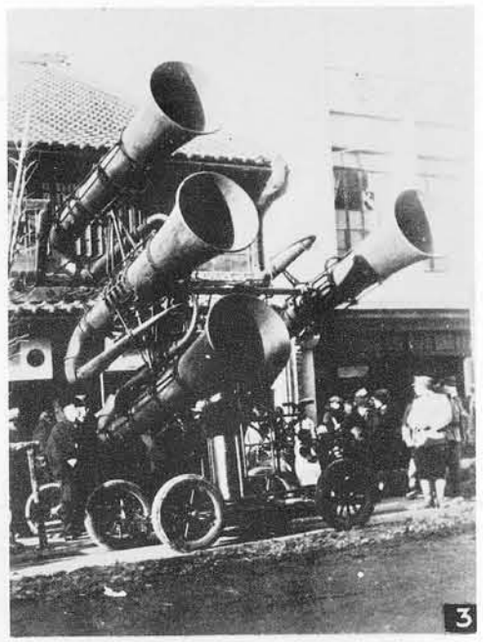

3

1. Model 1933 Comparator for use with the Model 1930 Sound Locator and Model 1933 150 cm. Searchlight.

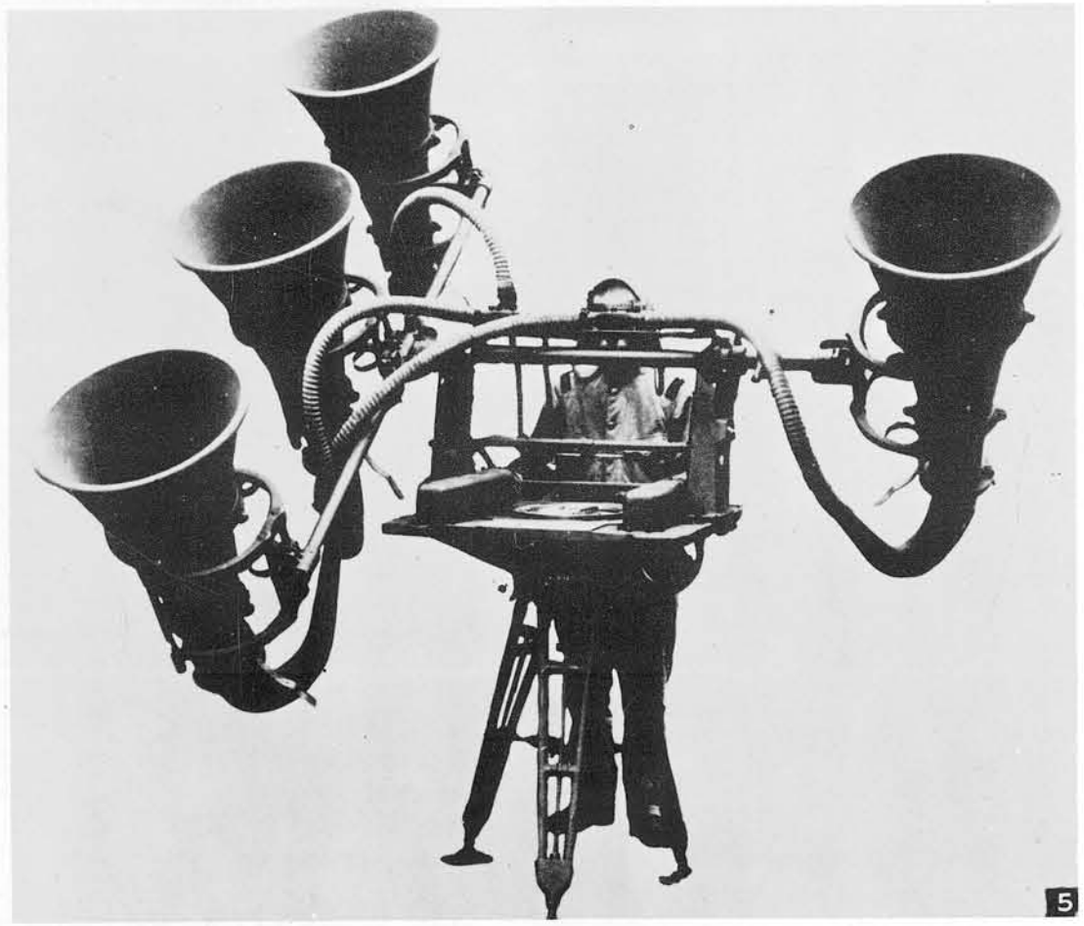
2. Model 1933 Comparator in place showing its small size and ease of concealment.

3. Large type Sound Locator which antedates the Model 1930. This equipment may be encountered in the Japanese Homeland.

4. Model 1933 (or a modification thereof) 150 cm. Searchlight with canvas cover.

5. Model 1930 small Sound Locator. Due to light construction it is rarely observed unless revetted.


4


5

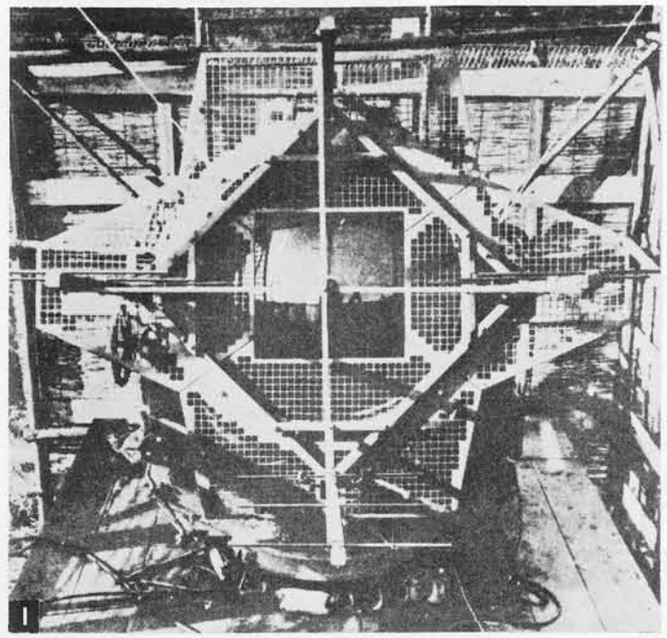
SEARCHLIGHTS
EQUIPMENT, RADAR CONTROL

The "MK. IV, Mod. 3" Searchlight Control Radar is evidentally a Japanese adaption of the British S.L.C. and consists of two parts:

(A) Transmitter with Yagi antenna mounted on a searchlight controller, the mount (with operator's seat) revolves and is about 8' wide.

(B) Receiving antennae of 4 Yagis attached to the face of a 110 cm. searchlight.

1. Captured photo of Receiving Antennae.
2. Transmitter with Yagi Antenna removed - PELELIU.
3. Captured photo of Transmitter Antenna.
4. Emplaced Transmitter Antenna - SAIPAN.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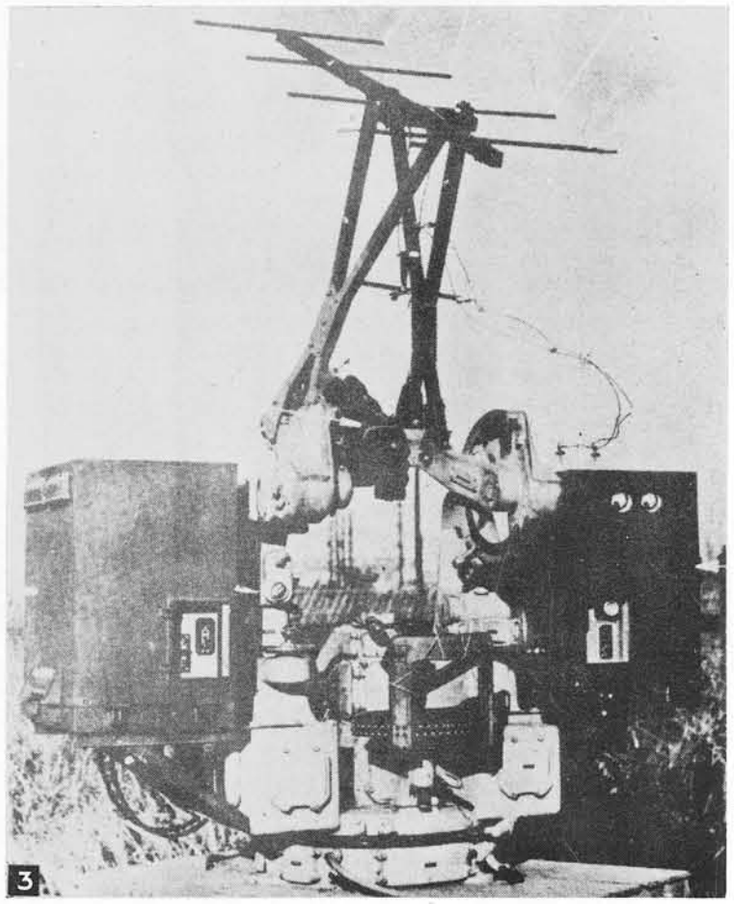
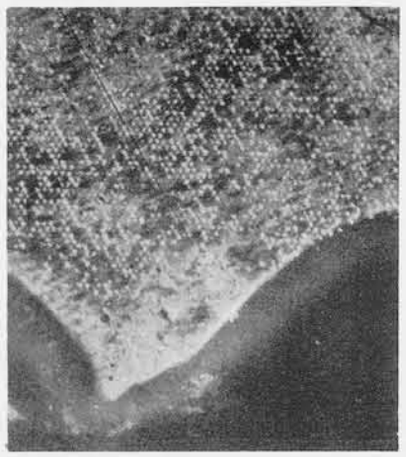

3

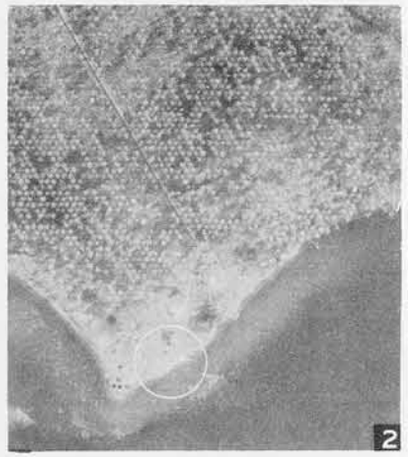

4

SEARCHLIGHTS

RAIL CONNECTED POSITIONS AND GENERATOR TRUCK REVETMENTS

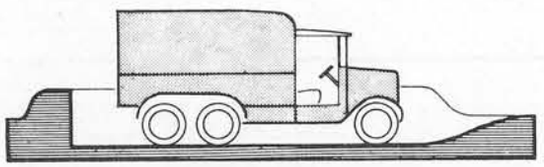

1




2


3

1. VILA, KOLOMBANGARA ISLAND. This rectangular revetment, 15' x 30', contained a generator truck for searchlight operation.
2. VILA, KOLOMBANGARA ISLAND. 1:10,000. A stereo-pair of the revetment shown in #1.
3. VILA, KOLOMBANGARA ISLAND. Two generator trucks and two 150 cm. searchlights. The generator is operated by the truck engine.
4. WAKE ISLAND, 1:4000. A raised searchlight revetment and protective shelter, 40' apart, are connected by rail. The position is 800' from a coast defense battery and commands a clear seaward sweep. During daylight hours or periods of disuse, the light is housed in the shelter.
5. PEALE ISLAND, WAKE, 1:3250. Rail connected searchlight position and shelter are 100' apart; the complete unit is 900' from 8" coast defense battery.
6. ROI ISLAND, KWAJALEIN ATOLL. The remains of this position are similar to those of Wake Island. The light is the 150 cm. size; tracks are about 3' wide.



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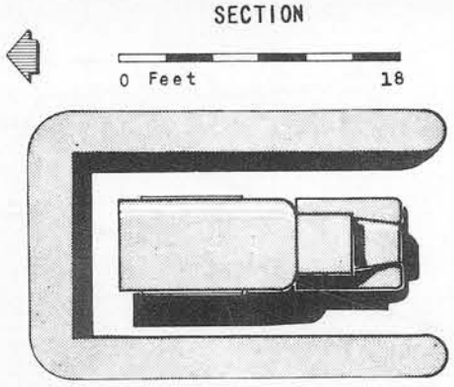
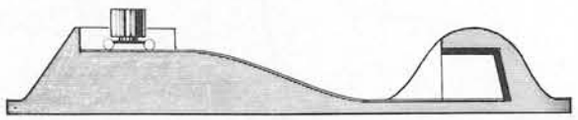


0 Feet 18

PLAN-GENERATOR TRUCK



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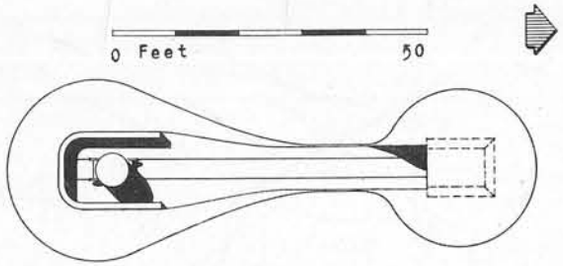
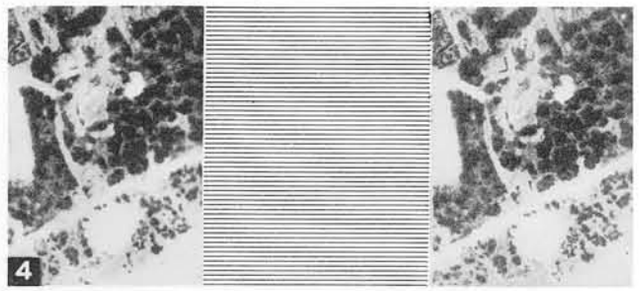


0 Feet 50

PLAN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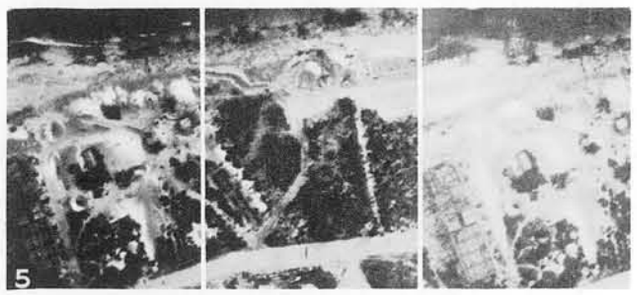
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6

SEARCHLIGHTS

CIRCULAR REVETMENTS

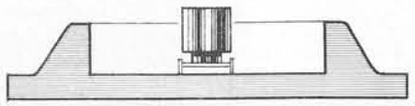
Circular revetments are the most common emplacements for searchlights. Inner diameters vary from 8' to 35'. A 150 cm. light with extended hand control requires a 27' diameter (or larger) revetment since the radius from the light center to the end of the bar is 12'. Openings in revetment walls, if over 6' wide, will accommodate mobile lights.

1. MANILA, LUZON ISLAND, 1:3000. Searchlight with manual control bar in a 27' revetment. The 15' revetment with adjacent pit indicates a sound locator and comparator.

2. MAIN CAMP, KISKA ISLAND, 1:3050. A 16' diameter revetment containing a 98 cm. fixed searchlight. The building in the upper left is a sub-station to increase amperage from regular lines.

3. MAIN CAMP, KISKA ISLAND — 98 cm. fixed searchlight

4. VILA, KOLOMBANGARA ISLAND — 150 cm. searchlight



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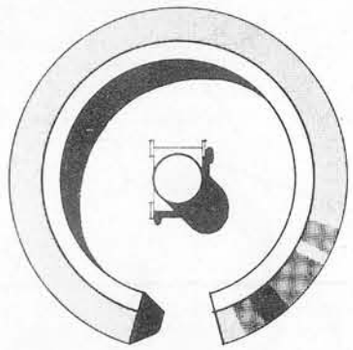
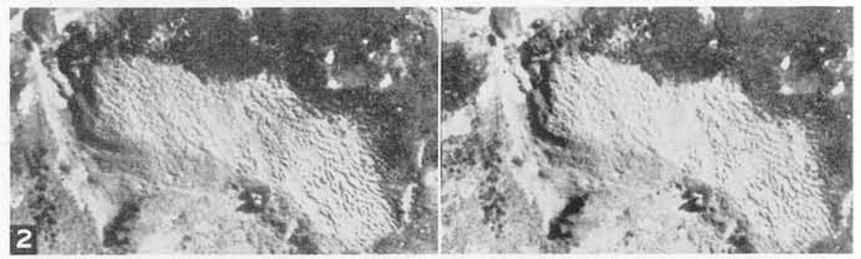


PLAN

1



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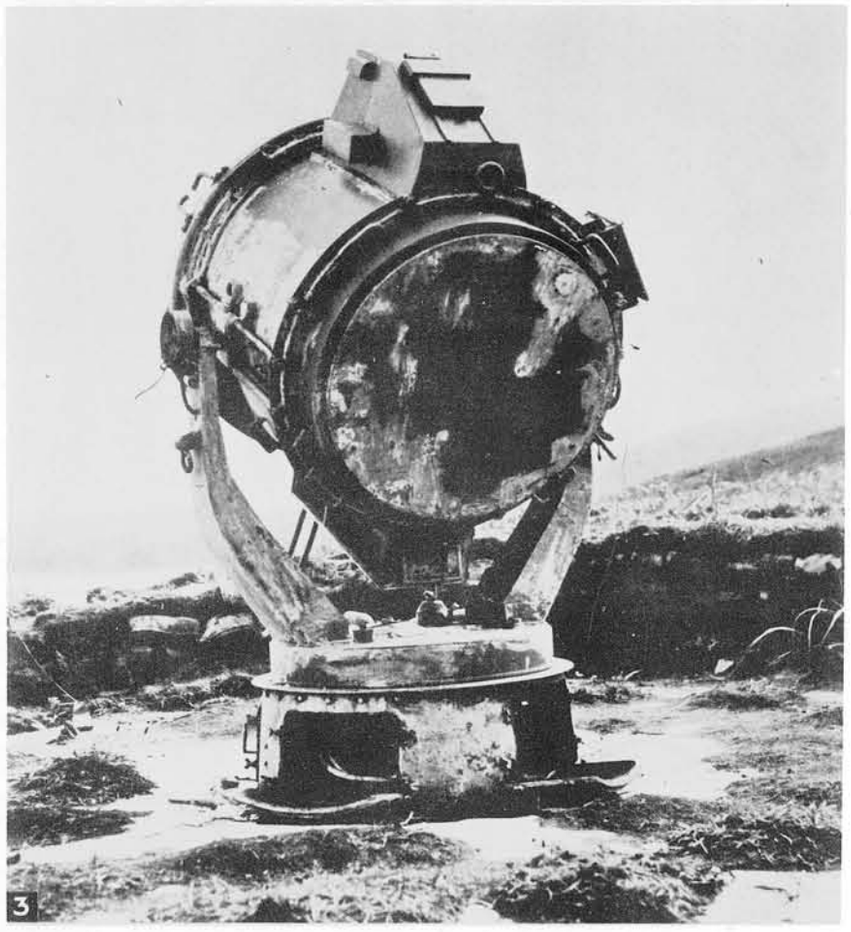
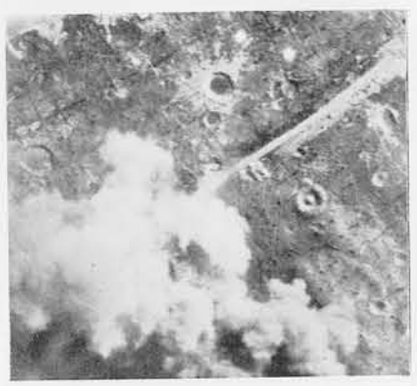


3

CONFIDENTIAL

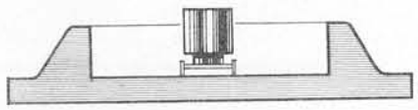
SEARCHLIGHTS

CIRCULAR REVETMENTS



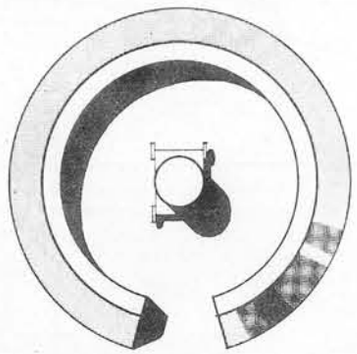
1

2



SECTION

0 Feet 25



PLAN

1. BORAM, NEW GUINEA, 1:4000. Revetment with 30' diameter situated 500' from a 75 mm. AA battery. The roadside excavation could accommodate a generator truck.

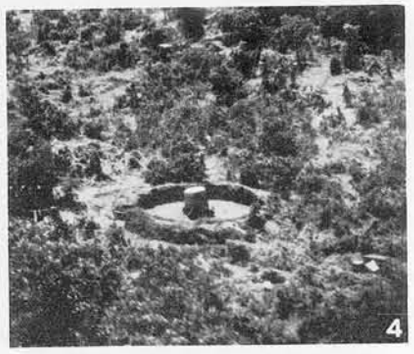
2. WEWAK, NEW GUINEA, 1:3250. Searchlight revetment with 26' diameter.

3. BORAM, NEW GUINEA, 1:6300. A stereo-pair of the camouflaged position shown in #5. The largest revetment contains the light; a saucer-shaped sound locator revetment is above and to the left of the light.

4. BUT DROME, NEW GUINEA, 1:600. An oblique view of a 150 cm. canvas-covered light in a 31' diameter position. Note the electric cables and the extended hand control.

5. BORAM, NEW GUINEA. A camouflaged position with palm fronds around the light and all revetments grass covered. The sound locator revetment is saucer-like in shape.

3



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5

SEARCHLIGHTS

CIRCULAR SOUND LOCATOR REVETMENTS

Sound locators become distinctive identification features when placed within saucer-like revetments. Usually the revetments are about 35' in diameter and located about 100' from the searchlight. A small revetment for the comparator should be found near the sound locator.

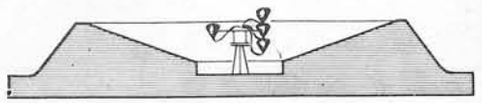
1. NANKING, CHINA, 1:5900. Saucer-like sound locator revetment located 90' from a double-wall searchlight revetment.

2. MATUPI ISLAND, An oblique view of a sound locator revetment in conjunction with a searchlight in a log structure. A comparator is in the tree.

3. KASHIWABARA WAN, PARAMUSHIRO ISLAND, 1:6000. Occupied and empty positions typical of searchlight stations in the Kashiwabara-Kataoka area. Inner diameters of searchlight and sound locators are 30' and 35', respectively. The revetments are 100' - 120' apart, connected by trail or communication trench.

4. KATAOKA, SHIMUSHU ISLAND, 1:10000. Occupied and empty positions. Note the shelter incorporated in the occupied searchlight revetment and the crews' quarters.

5. SAWAR, NEW GUINEA. The comparator would normally be contained in a small revetment near the sound locator; remaining small revetments would contain M.G. or automatic weapons.



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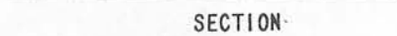
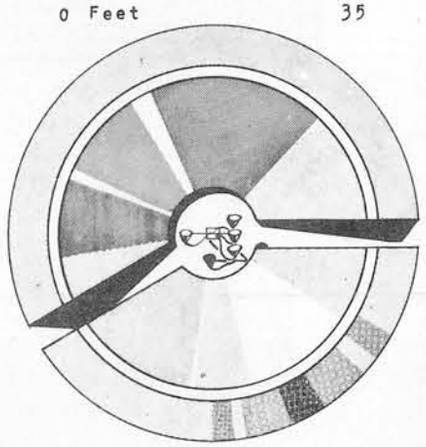
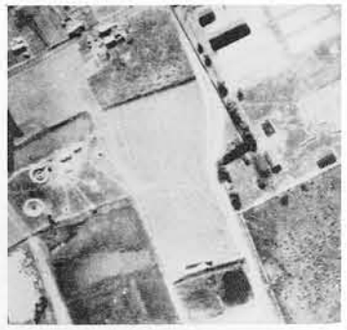
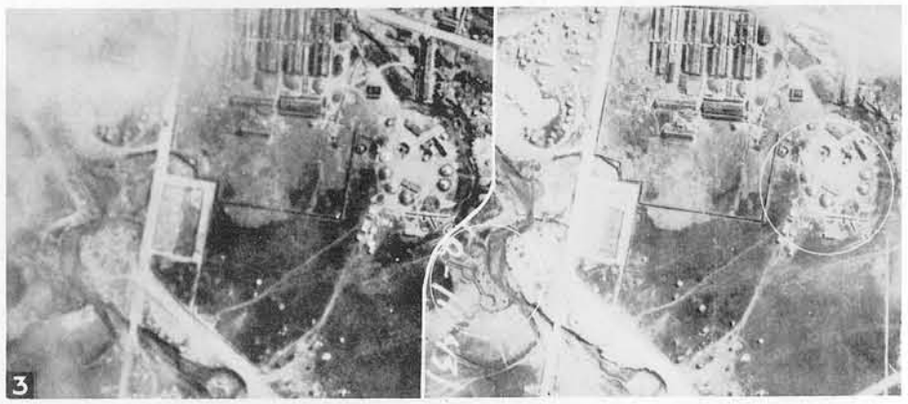
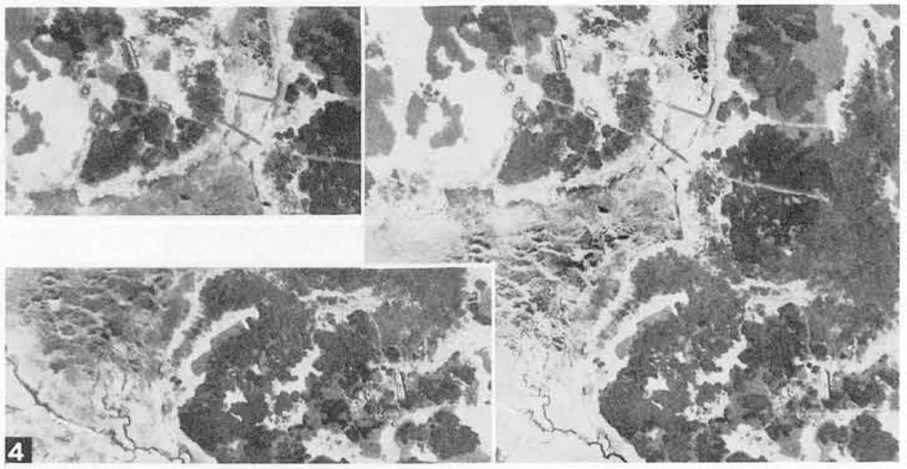


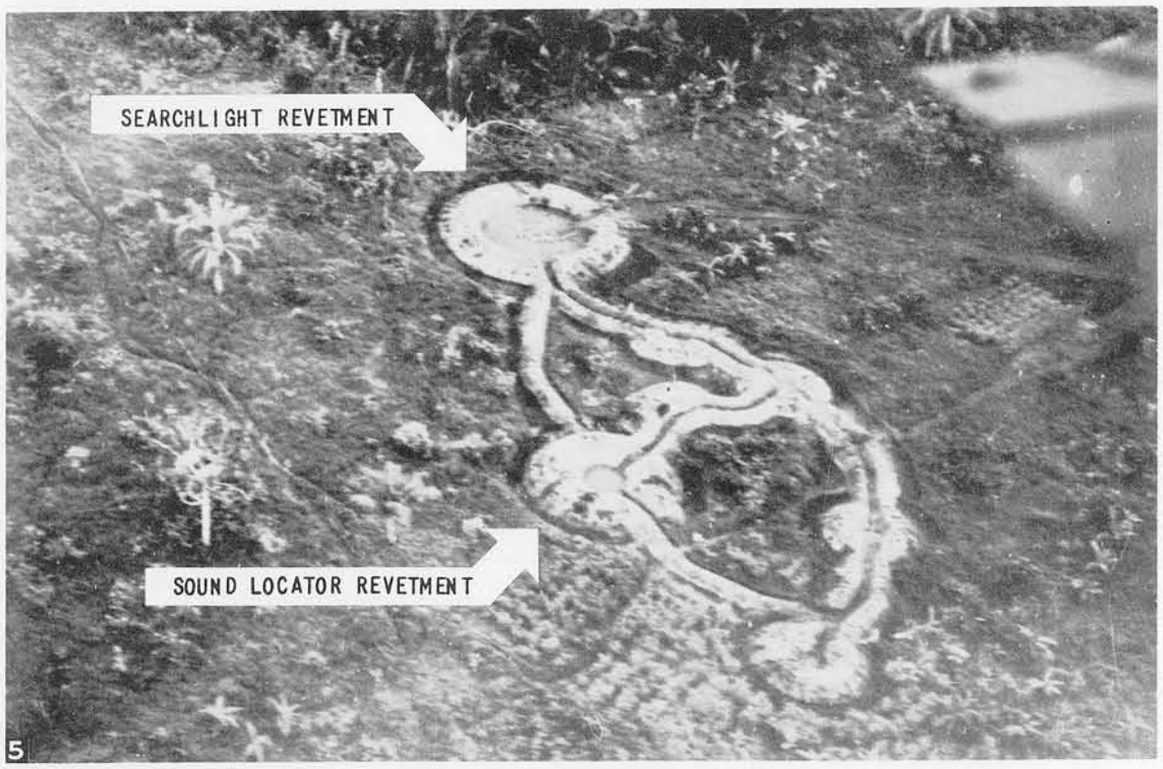


PLAN









SEARCHLIGHTS

CIRCULAR REVETMENTS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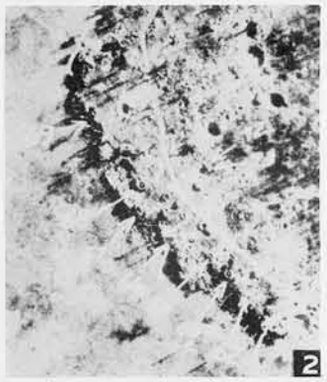
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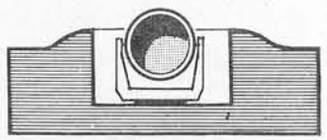

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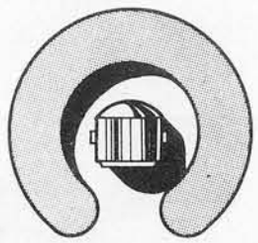


PLAN

In the absence of characteristic searchlight shadow and as the diameter of the revetment decreases, it becomes increasingly difficult to distinguish between searchlight and automatic gun positions.

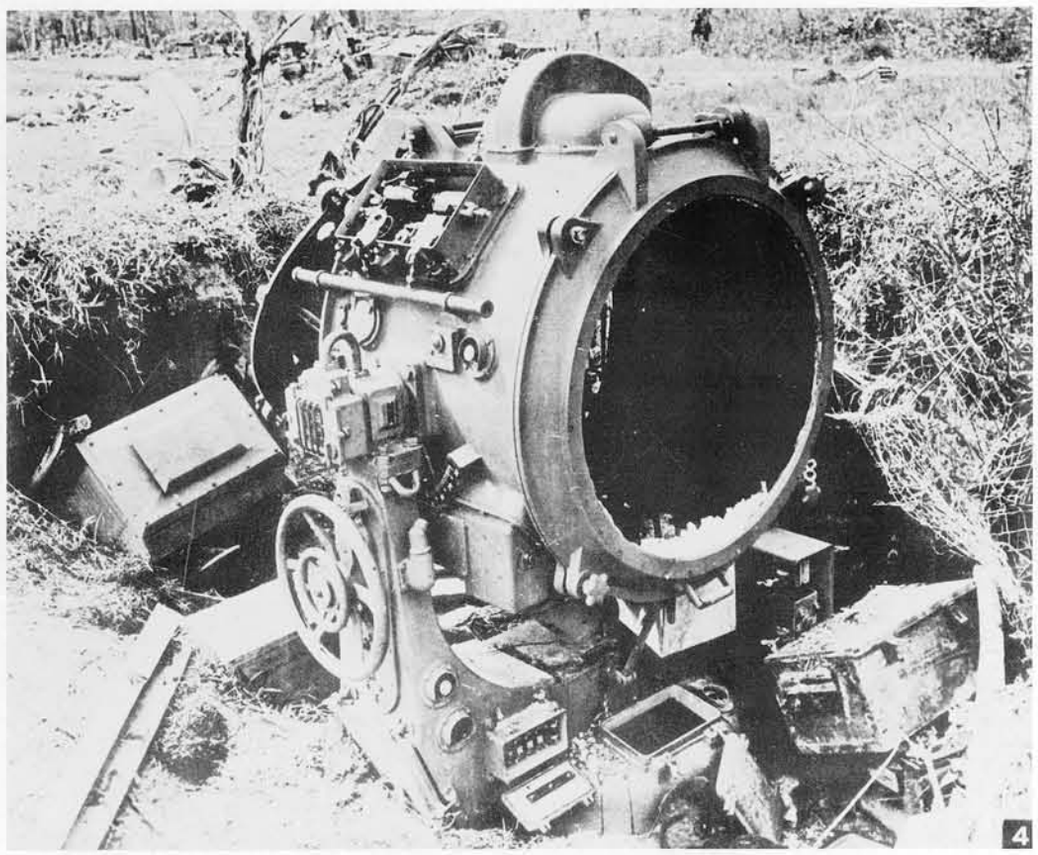
MUNDA POINT, NEW GEORGIA ISLAND.

1. A 60cm. searchlight emplaced in a rough, circular excavation 8' in diameter.

2. Stereo-pair of the lights shown in #1 and #2, including associated AA guns. The circled building was a powerhouse which supplied the search lights. Scale 1:4000

3. A 60 cm. searchlight in an 8' diameter revetment.

4. Closeup of #3 reveals the presence of a camouflage net.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SEARCHLIGHTS
DOUBLE-WALL REVETMENTS

Double-wall revetments provide for the manual operation of a searchlight with extended hand control; the outer circle is used as a walk by the operator; the inner space contains the light. From available examples, it is indicated that double-wall revetments contain mobile lights since the walls are provided passageways 6' to 10' wide.

1. FUTAMI KO, CHICHI JIMA, 1:8300. The path emanating from the double-walled revetment toward the point leads to a protective shelter for the light. A saucer-shaped sound locator revetment and a four-gun battery.

2. VILA, KOLOMBANGARA ISLAND, 1:10000. NOT SEARCHLIGHT POSITIONS BUT GUN POSITIONS. The two extreme right revetments with fire control post between contain 40 mm guns, and the remaining positions contain 25 mm and 13.2 mm guns. The outside revetments, 45'-65' in diameter, are to provide drainage; the inner revetments are 12'-15' in diameter. Note that the outer circle is not continuous and there is no provision for mobile equipment. Searchlights complement gun batteries, but are not themselves found in battery patterns.

3. BORAM, NEW GUINEA. A 150 cm. mobile light with extended hand control. Outer and inner revetment are 33' and 12', respectively.

4. MINGALDON, BURMA. This double-walled searchlight position is one of seven around the aerodrome. Outer and inner walls are respectively 35' and 15' in diameter.


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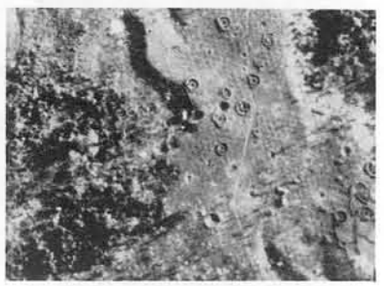
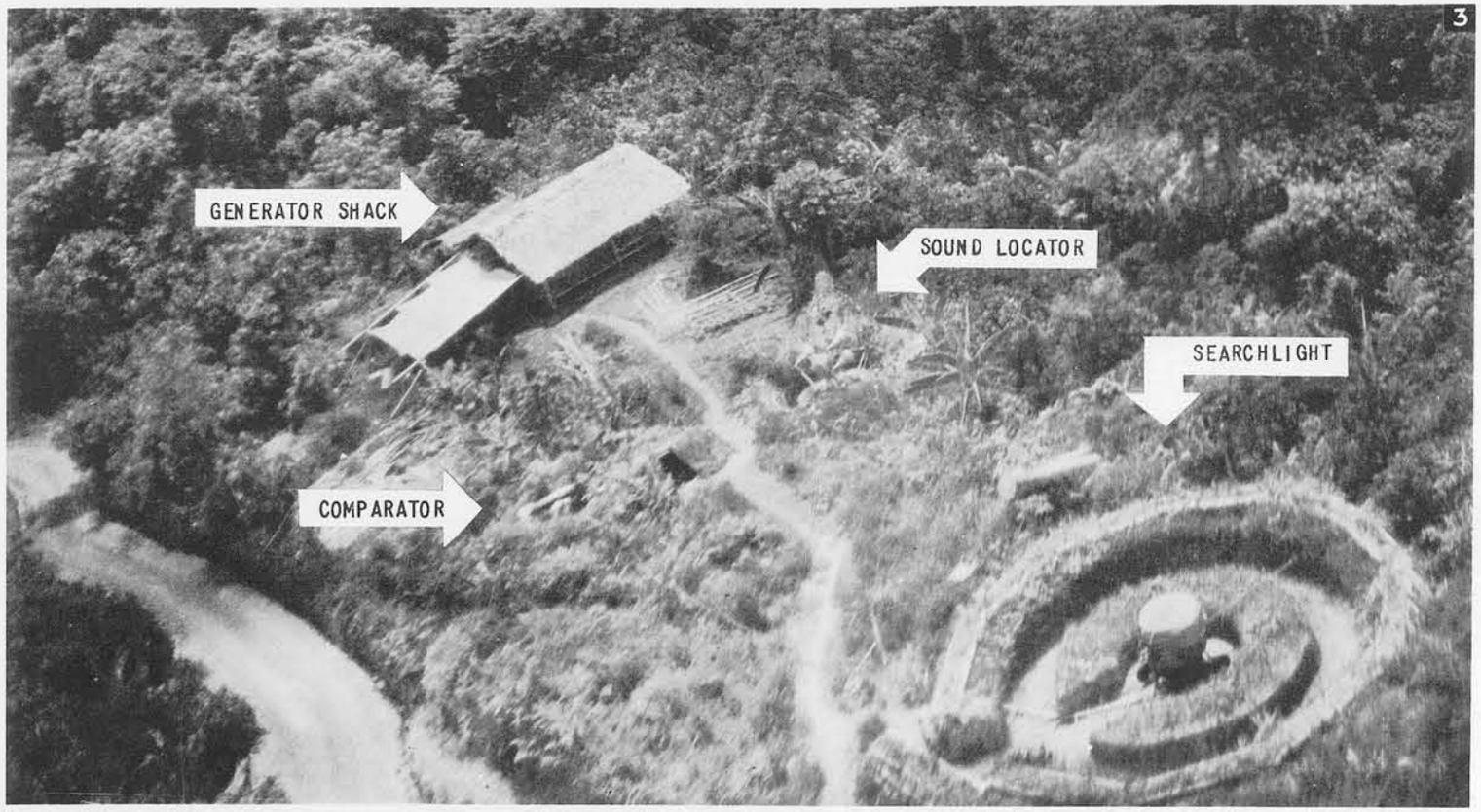
2





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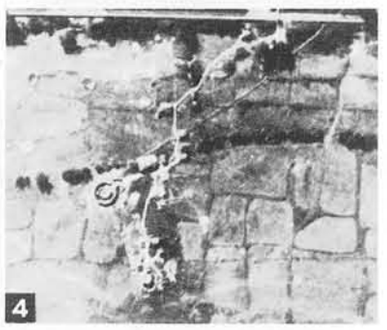
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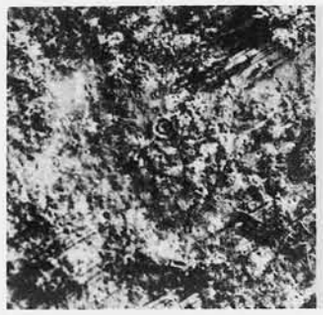
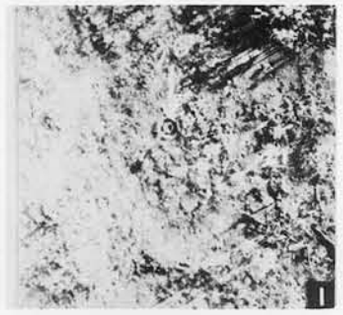
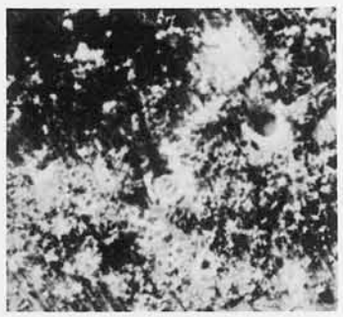
PLAN

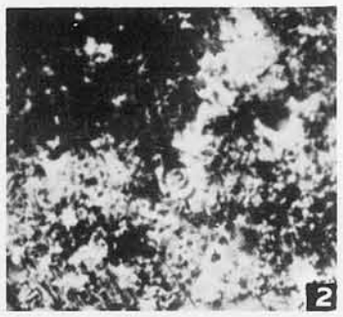
SEARCHLIGHTS

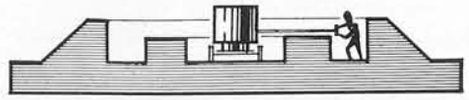
DOUBLE-WALL REVETMENTS











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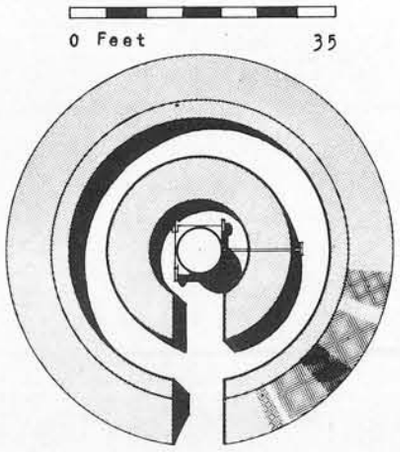

PLAN

1. MUNDA POINT, NEW GEORGIA ISLAND, 1:5000. Outer and inner revetments measure 35' and 15' in diameter, respectively. A hideout for daylight concealment is 85' from the walled position.

2. MUNDA POINT, NEW GEORGIA ISLAND, 1:2800. A stereopair of the position shown in figure 5. The diameters of outer and inner revetments are 35' and 15', respectively. Roughness of outline is due to rock and coral blocks used in construction.

3. NANKING, CHINA, 1:5900. Double-walled searchlight revetment 90' from a 35' diameter sound locator revetment.

4. MUNDA POINT, NEW GEORGIA ISLAND. This ground shot shows the rough construction and materials.

5. MUNDA POINT, NEW GEORGIA ISLAND. A break (6'-7' wide) through the walls provides for movement of the light.

SEARCHLIGHTS
CIRCULAR PLATFORMS

Platform mounted lights are commonly used in conjunction with 127mm D.P. gun batteries. Detection and direction instruments for platform mounted lights have rarely been found; if this apparatus is installed in the fire control centers of related gun batteries, there is no definite proof of it.

Generator equipment is sometimes housed underneath the raised platform.

1. WAKE ISLAND, 1:6000. The circular searchlight platform is 500' from a 127mm gun battery.

2. WAKE ISLAND, 1:1300. Shape and shadow identify this searchlight mounted on a raised circular platform about 12' in diameter. Notice the cable leading off to the right.

3. NAMUR ISLAND. A 150 cm. searchlight on a platform 12' in diameter and about 8' high. Steel framework is set in concrete. The space under the platform is enclosed by placing coconut logs against the steel framework.


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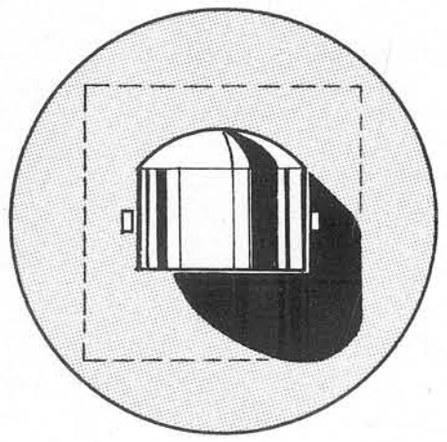


PLAN


3

SEARCHLIGHTS

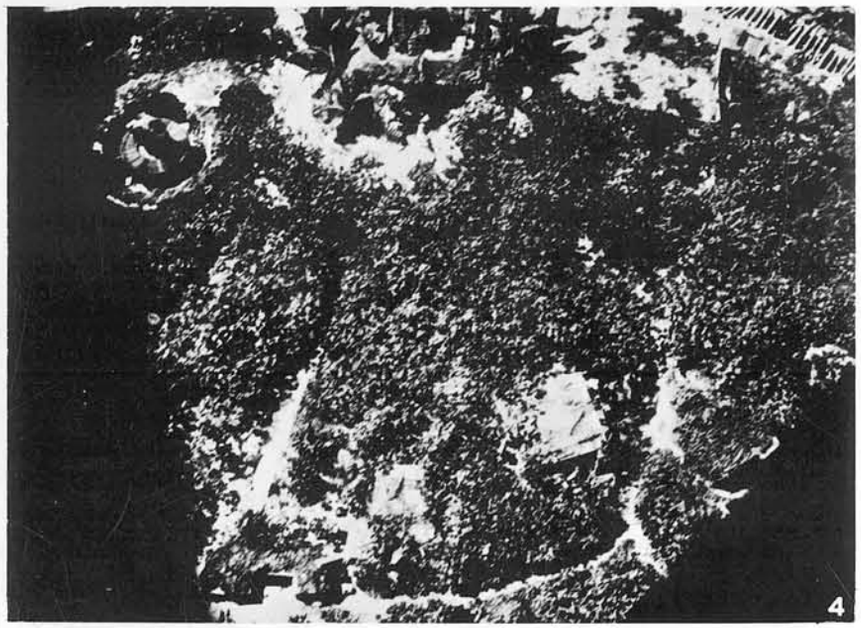
CIRCULAR PLATFORMS

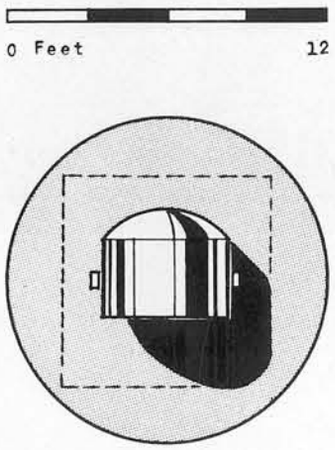
1. MILLE ISLAND, 1:4500. Stereo-pair showing the relationship of searchlights and 127mm gun battery. The lower light position is partially obscured by palm trees. Bombing has caused some obliteration.

2. WOTJE ISLAND. Canvas covered searchlight atop a circular platform. Typical of most island searchlight positions, this location commands a clear seaward sweep.

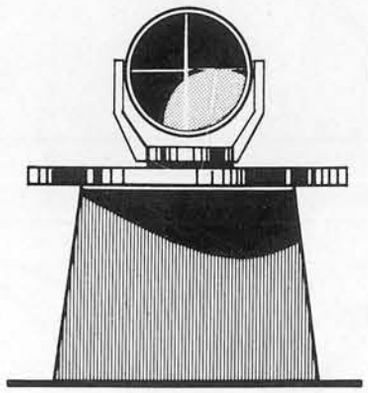
3. MILLE ISLAND. Canvas covered searchlights on either side of the island are mounted on circular platforms emplaced in "U" shaped revetments. Since ground surveys have shown generator equipment to be placed under some searchlight platforms, revments may indicate the presence of such equipment.

4. KWAJALEIN ISLAND. Canvas covered searchlight upon a revetted platform.





PLAN



ELEVATION

SEARCHLIGHTS

RAISED REVETMENTS—CIRCULAR AND RECTANGULAR

RABAUL, NEW BRITAIN

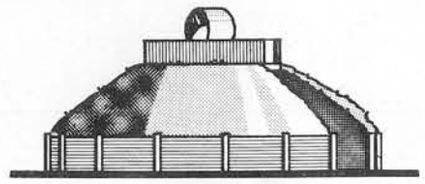
1. Stereo-pair (1:10000) of searchlights and 127mm gun battery on Sulphur Creek. The light tone of the lights is common, due either to canvas covers or high reflection from the rounded surfaces. Oblique views #2 and #3 show the 150cm lights to be within revetments built on rounded earth covered structures. Bombing has damaged gun revetments and fire control post.

2. Closeup (1:800) of the canvas covered light shows the revetment supported by a structure of logs covered with earth.

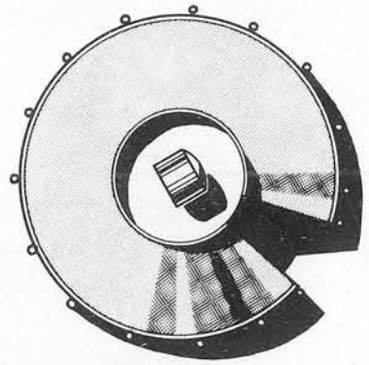
3. The entrance underneath searchlight "A" may indicate housing for generator equipment. "B" is shown in figure 2. "C" is the four-trumpet sound locator within a revetment. "D" houses the director. The gun battery is off the picture to the right.

4. WAKE ISLAND, 1:6000. These raised revetments are about 400' and 500' from the center of the 127mm gun battery. Differing from the Sulphur Creek lights, entrance is made over the surface of the mounds; and generators are likely housed in small buildings alongside the positions instead of being directly under the lights.

5. MATUPI ISLAND. The log structure forms a square revetment around the light. Sound locator is made apparent by the saucer-shaped revetment. A comparator is mounted in the tree between light and sound locator.



ELEVATION



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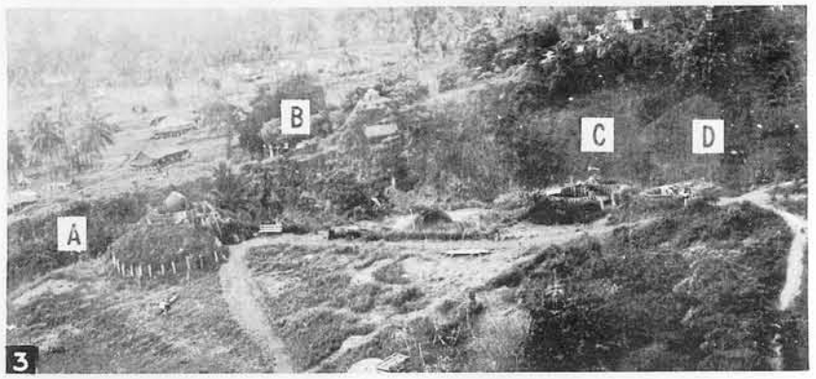
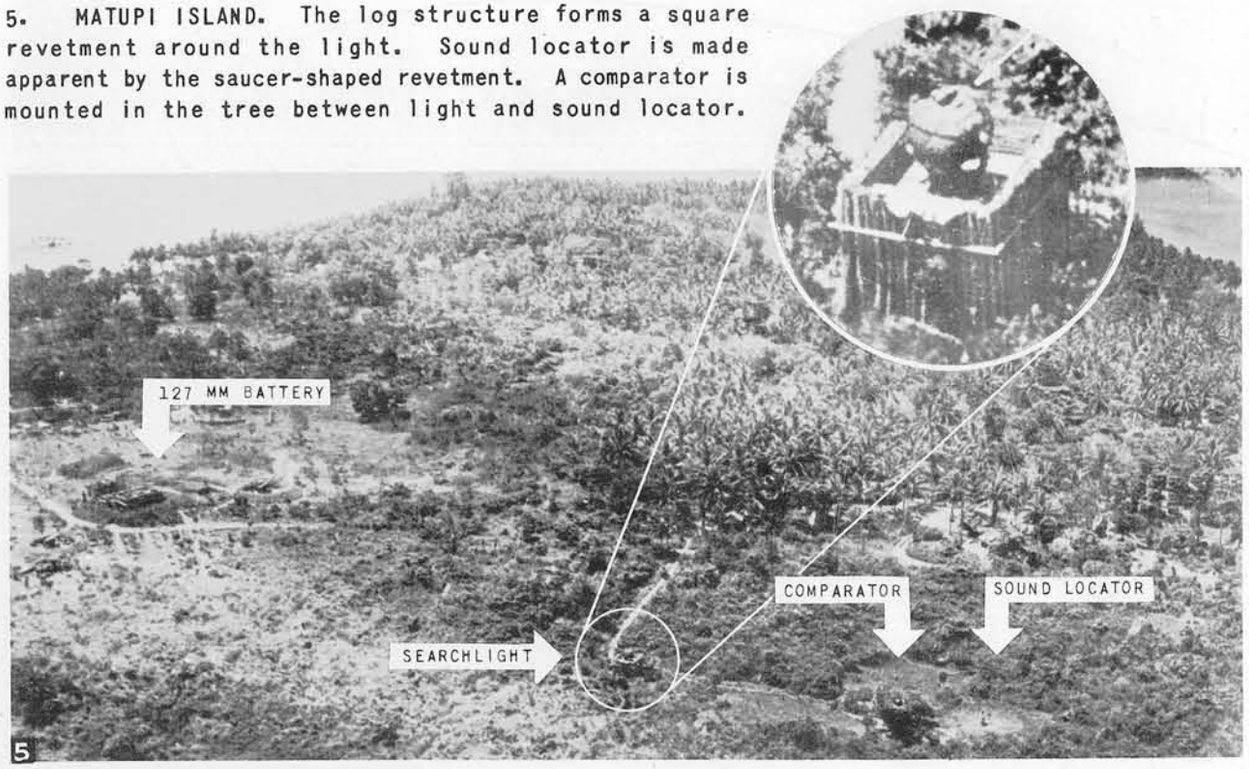
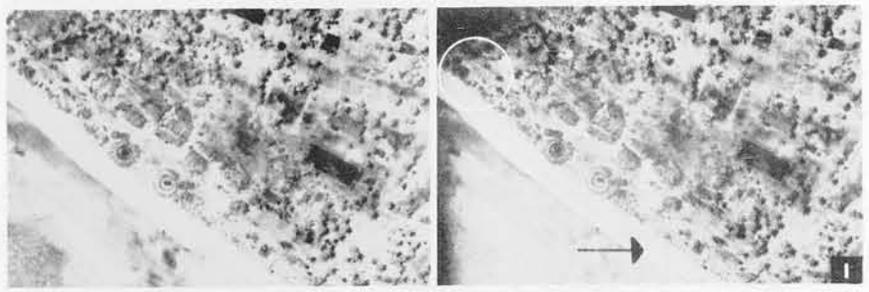
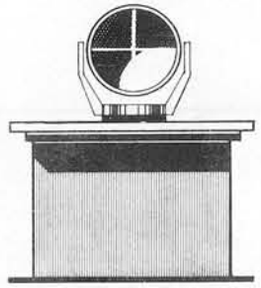




SEARCHLIGHTS

RECTANGULAR PLATFORMS





ELEVATION

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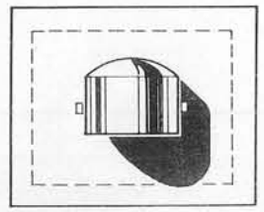


PLAN

BETIO ISLAND, TARAWA ATOLL

1. 1:4800. The circled installation is a 150 cm. searchlight mounted upon a rectangular concrete building 300' from a 127 mm. AA battery. To the lower right is a searchlight atop a circular platform.

2. Another example of a searchlight mounted atop a concrete building. Note the 127 mm. AA battery.

3. Low oblique of the structure in #5.

4. SAIPAN ISLAND. A rectangular wooden platform supporting a searchlight (estimated to be 110 cm). Dummy installations similar to this were also found.

5. BETIO ISLAND. This 150 cm. searchlight is mounted on top of a 10' x 12' x 8' reinforced concrete building containing generator equipment.

SEARCHLIGHTS

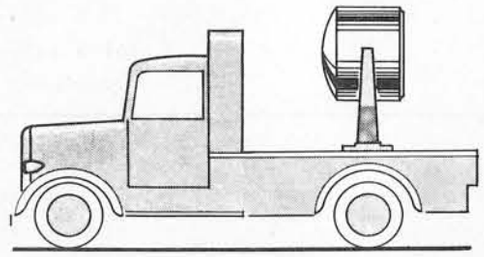
TRUCK MOUNTED LIGHTS AND NON-REVETTED POSITIONS

1. VILA, KOLOMBANGARA ISLAND. Non-revetted searchlights in a plantation. The obstruction of the beam by trees is occasionally disregarded.

2. WAKE ISLAND. A mobile searchlight located in a shallow ditched area off the main road. Wheel tracks and cylindrical shape of the light are the only clues to identification.

3. VILA, KOLOMBANGARA ISLAND. An additional pair of non-revetted 150 cm. searchlights.

4. BETIO ISLAND, TARAWA ATOLL. This 98 cm. searchlight truck represents standard equipment that has also been taken on Saipan, Peleliu, Lae-New Guinea, and Little Kiska Island. Small size and ease of movement make this light practically impossible to detect. Power for operation of the light is supplied by a built-in generator run by the truck engine. On Little Kiska, the searchlight truck was dug in, camouflaged with nets, and gave the appearance of a small building; on Saipan trucks were housed in underground concrete garages.



ELEVATION

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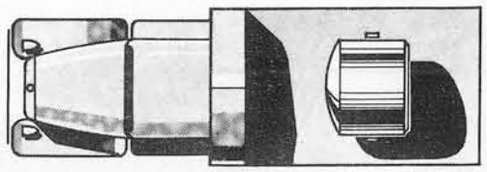
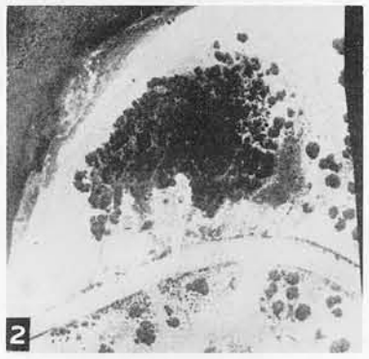


PLAN

1



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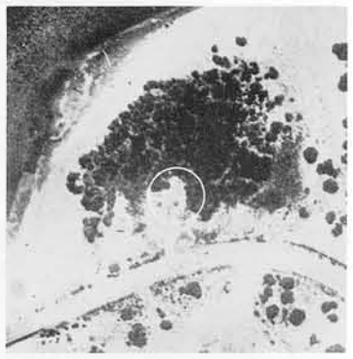

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4

CONFIDENTIAL

SEARCHLIGHTS

RELATIONSHIP OF GUNS AND SEARCHLIGHTS

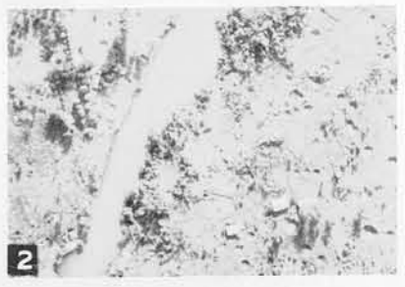

1

It is common to find two 150cm searchlights within a 500' radius of a 127mm twin-mount D.P. gun battery; occasionally only one light may accompany a battery.

1. MILLE ISLAND. Searchlights, on circular platforms, are on either side of the island and within a 330' radius of the battery.

2. RABAUL, NEW BRITAIN 1:7500. Stereo-pair of #3. Fire control center for the 127mm battery has been virtually bombed out.

3. A low oblique reveals sound locator and director revetments. One searchlight is obscured by the phosphorus bomb burst at the top of the picture; one gun is off the photo to the right.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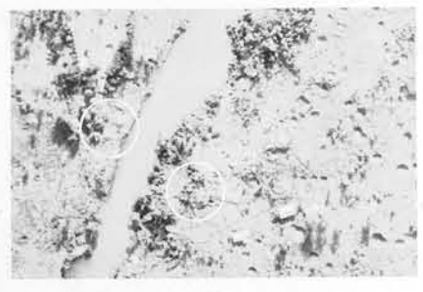
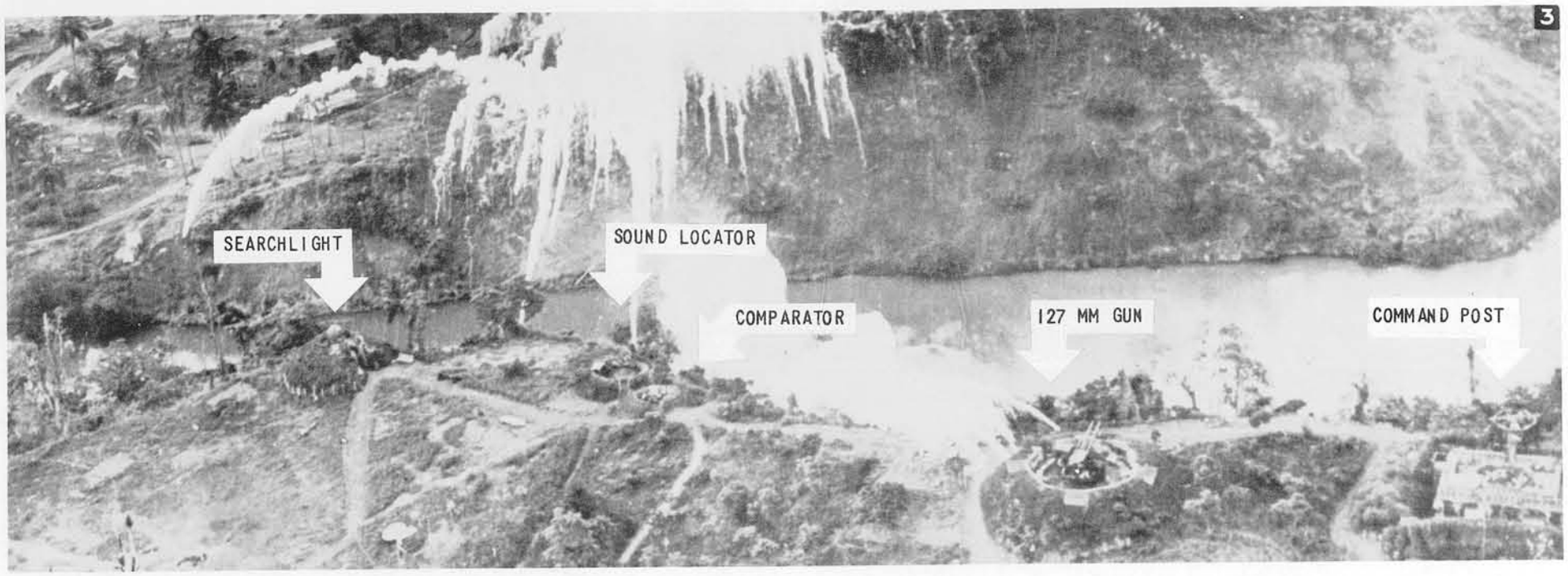




SEARCHLIGHTS

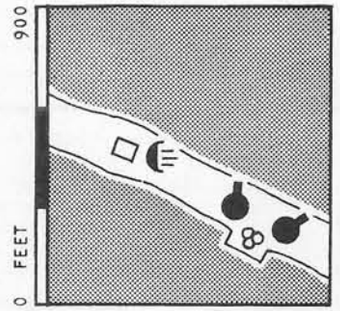
RELATIONSHIP OF GUNS AND SEARCHLIGHTS

1. JALUIT ISLAND, 1:6500. One searchlight on a circular platform is 250' from the closest 127mm gun revetment. Note that the light is nearly white in tone.

2. VANAKANU, NEW BRITAIN, 1:6500. Searchlights are emplaced on either side of the gun battery, one in a raised revetment, the other in a square structure.

3. MILLE ISLAND, 1:3000. Stereo-pair of #4. Palm trees surrounding searchlights are a common occurrence. Only a part of the fire control center appears on the left between the guns.

4. MILLE ISLAND. Circular platforms are emplaced in 16' diameter revetments, bearing evidence to the housing of generator equipment beneath the platform. No searchlight director or detector is evident.

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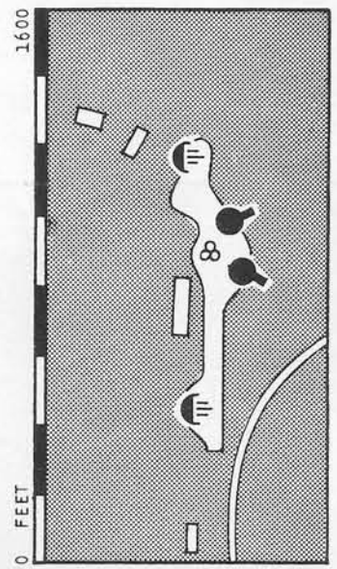


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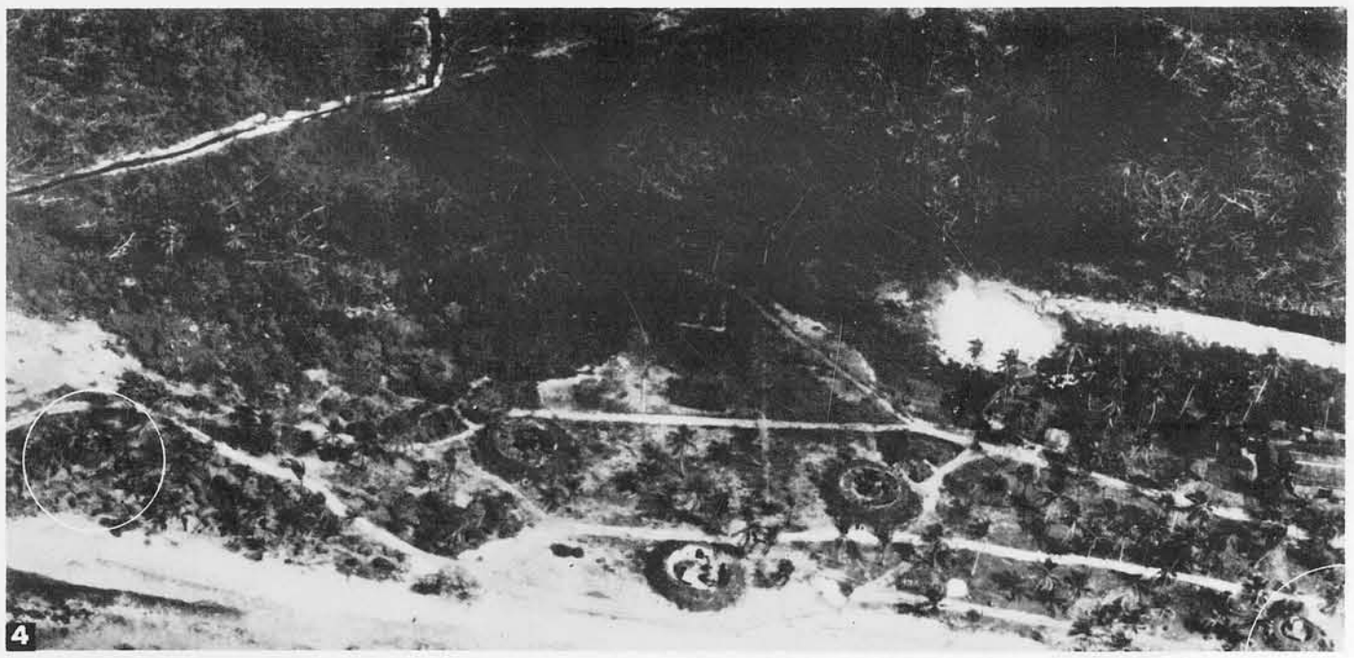
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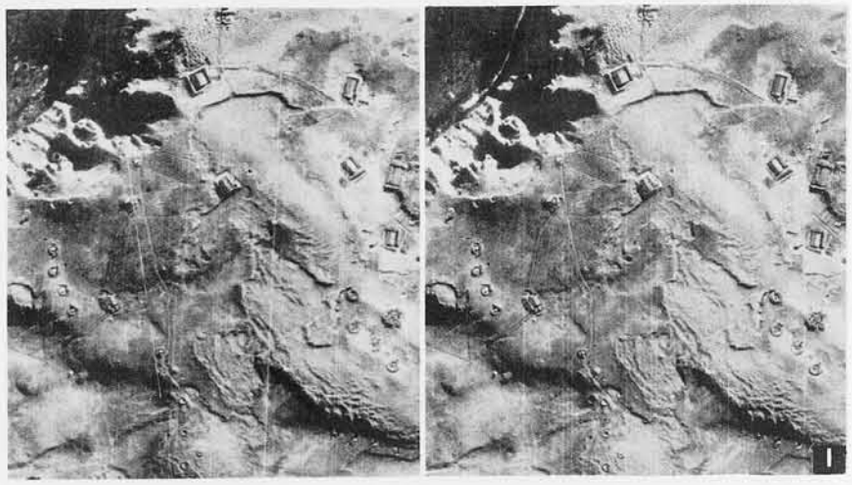
3

SEARCHLIGHTS

RELATIONSHIP OF GUNS AND SEARCHLIGHTS



Where coast defense and AA gun batteries have been found close together, searchlights have generally been placed to accommodate both. On flat coral islands, lights have most often been placed upon raised platforms along island perimeters, or upon points of land. On topography with hills or promontories, lights are placed to take advantage of such elevations. Such locations attest to the use of searchlights with coast defense guns.

1. NORTH HEAD, KISKA ISLAND, 1:7000. Two 150 cm. fixed searchlights emplaced between a 4.7" C.D. and a 75 mm. AA battery. The lights are within 450' of the C.D. battery and within 900' of the AA battery.

2. WAKE ISLAND. Two searchlights located between a 127 mm. D.P. and an 8" C.D. gun battery. One light is atop a high conical tower, while the other is mounted on a raised circular platform.

3. NORTH HEAD, KISKA ISLAND. A low altitude vertical of #1 showing the 4.7" C.D. battery and the 150 cm. searchlights on either side.

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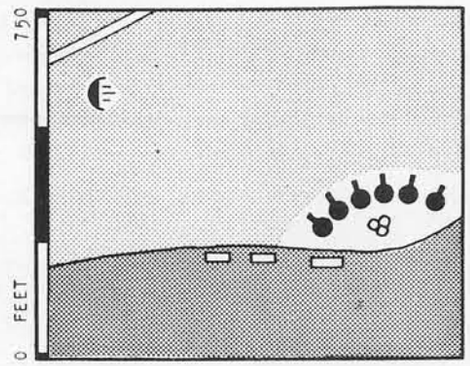
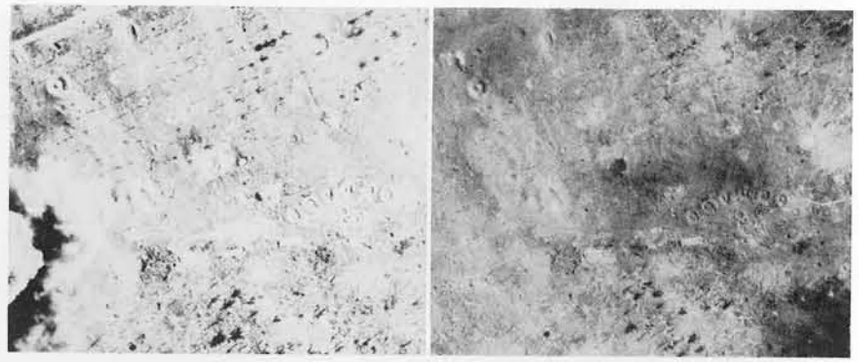
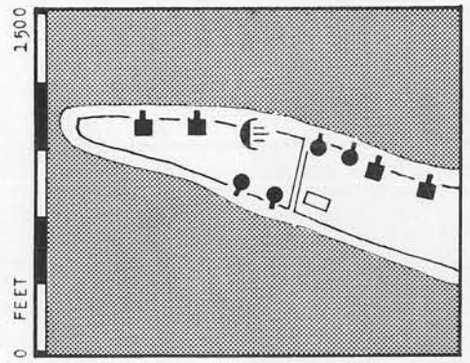
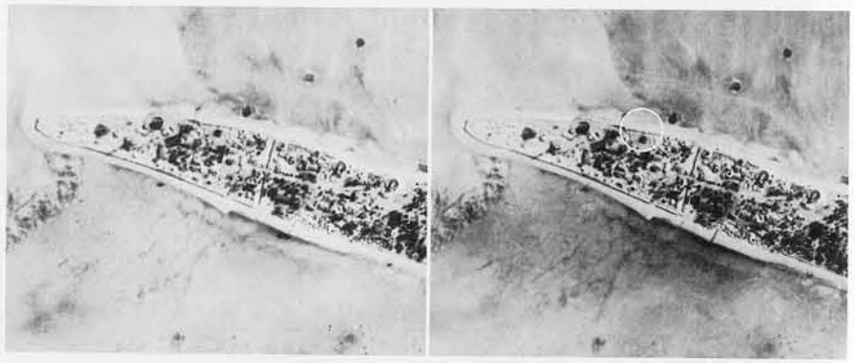
1. BORAM, NEW GUINEA, 1:5000. A searchlight in a circular revetment is 500' from a 6-gun 75mm. AA battery. The gun battery is situated on a ridge above the BORAM AIRFIELD.



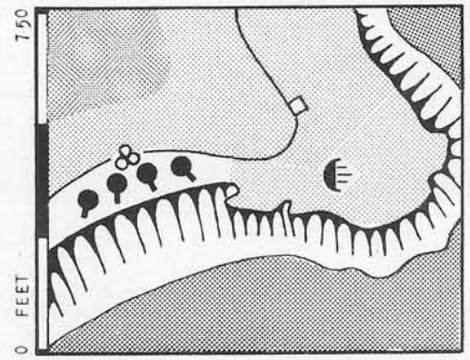


2. BETIO ISLAND, 1:10,000. A searchlight atop a rectangular structure is in such a location to be used with both 8" C.D. and 75mm. AA batteries.

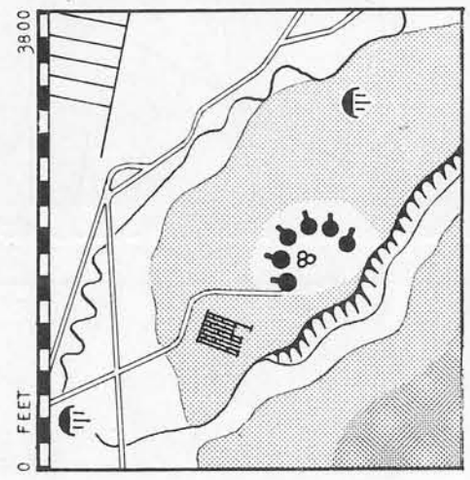


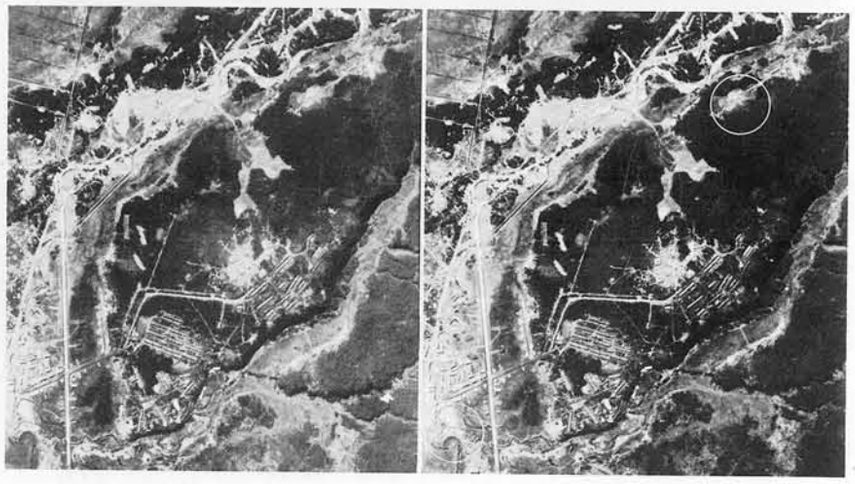


3. CHICHI JIMA, 1:5000. Double-wall searchlight and saucer-shaped sound locator revetments on the point are 450' from the fire control center of the 4-gun AA battery.



4. KASHIWABARA WAN, PARAMUSHIRO ISLAND, 1:18500. Two searchlights in circular revetments with associated sound locator revetments are within a 590' radius of the 6-gun 75mm. AA battery on top of the hill.





SEARCHLIGHTS
CAMOUFLAGE


1

The Japanese use of camouflage on searchlight positions is largely confined to natural cover or some method incorporating natural material. Effective blending with the surroundings will make a searchlight difficult, if not impossible, to detect.

1. PONAPE ISLAND. Palm fronds surround this canvas covered light in a raised revetment. Matting with leaves and fronds cover a 3-gun coast defense battery. A range finder may be seen in the center of the photograph.

2. MUNDA POINT, NEW GEORGIA ISLAND. A double-walled revetment covered with vines. Brush surrounds the position.

3. BORAM, NEW GUINEA. Palm fronds are leaned up against the light, and all revetments are covered with a coarse creeping grass.

4. BORAM, NEW GUINEA. A canvas covered mobile light is emplaced in an excavation under thick brush. Track activity should be noted in a vertical photograph, but the light is effectively covered.


2


3


4

SEARCHLIGHTS
CAMOUFLAGE

1. DAGUA, NEW GUINEA. A sound locator within a revetment covered by a pole frame. There is no attempt to cover the 150cm. light.

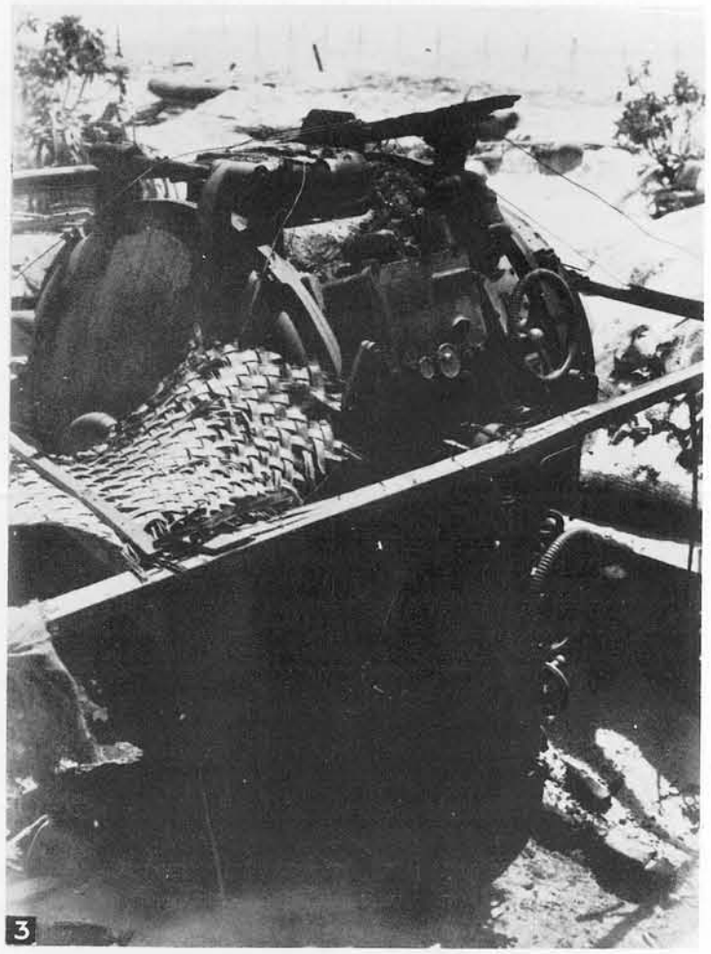
2. SAIPAN ISLAND. This dummy closely resembles an actual searchlight, and was placed in a logical relationship with a dummy coast defense battery.

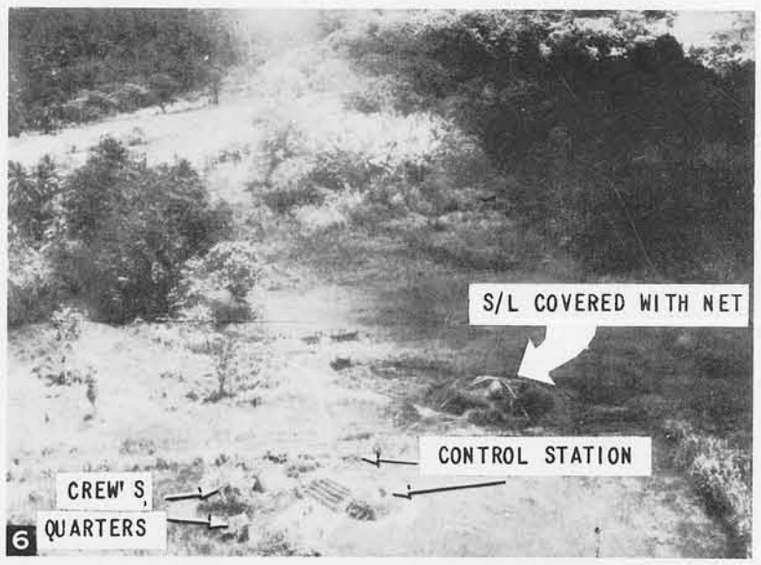
3. BETIO ISLAND, TARAWA. Pandanus matting upon a wire and wood frame. This covering would effectively alter the characteristic round shape of the searchlight. Identification might be made upon the basis of relationship with an adjacent gun battery.

4. LITTLE KISKA ISLAND. This searchlight truck was dug in and net-covered. Tundra vegetation was woven into the netting. On aerial photographs the installation had the appearance of a small revetted building.

5. HOLLANDIA, NEW GUINEA. Vertical view of #6.

6. HOLLANDIA, NEW GUINEA. Oblique photograph of a net-covered position, the net being held in place by two crossed poles. The searchlight can be seen. Revetments and quarters are sod-covered.

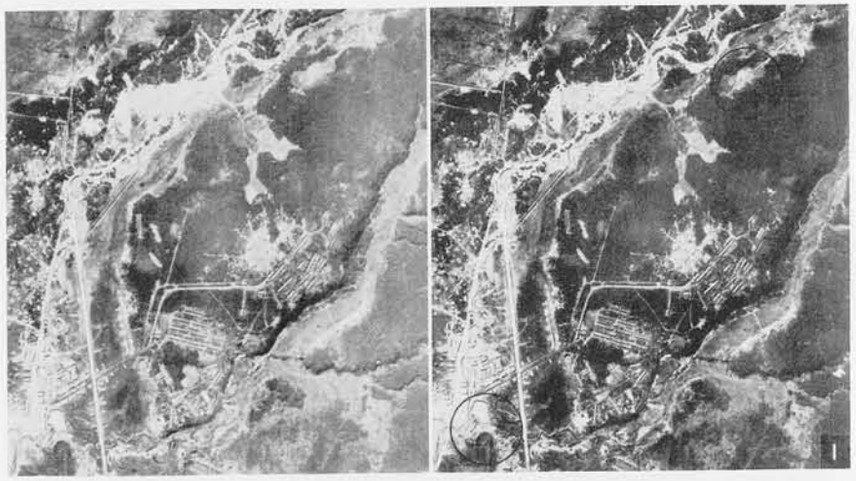




CONFIDENTIAL

SEARCHLIGHTS

NIGHT PHOTOGRAPHY INTERPRETATION



Searchlights on night photographs will appear as light discs or as tracks, depending upon whether the film is exposed instantaneously or for a period of seconds.

If an "open plate" exposure is made, the camera shutter remains open for some seconds, during which time the photo flash explodes. In such an exposure, the searchlight bowl, which is a fixed point on the ground, produces a track (or hem) like any other light or fire which varies only by the movement of the aircraft carrying the camera. The beam, on the other hand, which is caused by the transmission of the light through the atmosphere, varies according to the operation of the searchlight. The beam (or curtain) is often seen on night photos in fine thin lines at a sharp angle to the bowl track. The intensity of the beam varies directly with amount of water or other material suspended in the atmosphere. When the photographic aircraft is held in the searchlight, the beam will be absent.

If an instantaneous exposure is made and the camera shutter is tripped by a photo-electric cell at the moment of the flashbomb explosion, a searchlight will appear as a light spot in its correct ground location.

From "open plate" photographs, the method of locating the ground position of a searchlight is similar to that for fires. One difference is that a searchlight track may appear complete (beginning and ending within the limits of one frame) when actually the light can be extinguished voluntarily, producing a track that appears complete but is not.

Using one night photograph, the position may be located by referring a complete track and ground detail to a day photograph. Using two night photographs, one with a complete track, the ground detail of one film is superimposed upon that of the other, and the intersection of the tracks indicates the correct location of the searchlight. Again differing from fires, searchlights may be plotted by the intersection of tracks on photographs taken different nights.

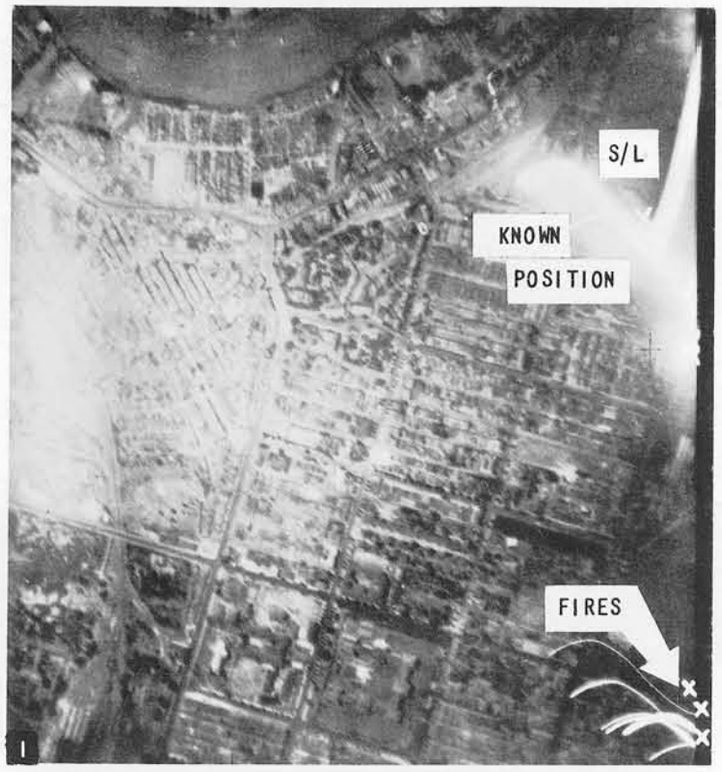
1. KASHIWABARA WAN, PARAMUSHIRO ISLAND - 1:18500. A daylight photograph showing searchlight and heavy AA positions seen in #2, a night photograph. These searchlights were originally detected from daylight photographs and were confirmed by night photographs.

2. KASHIWABARA WAN, PARAMUSHIRO ISLAND. An instantaneous night exposure showing two searchlights, the lower light directly engaging the aircraft. The lower light might be mistaken for the photoflash, but the shadows indicate that the flash was off the photograph to the left.

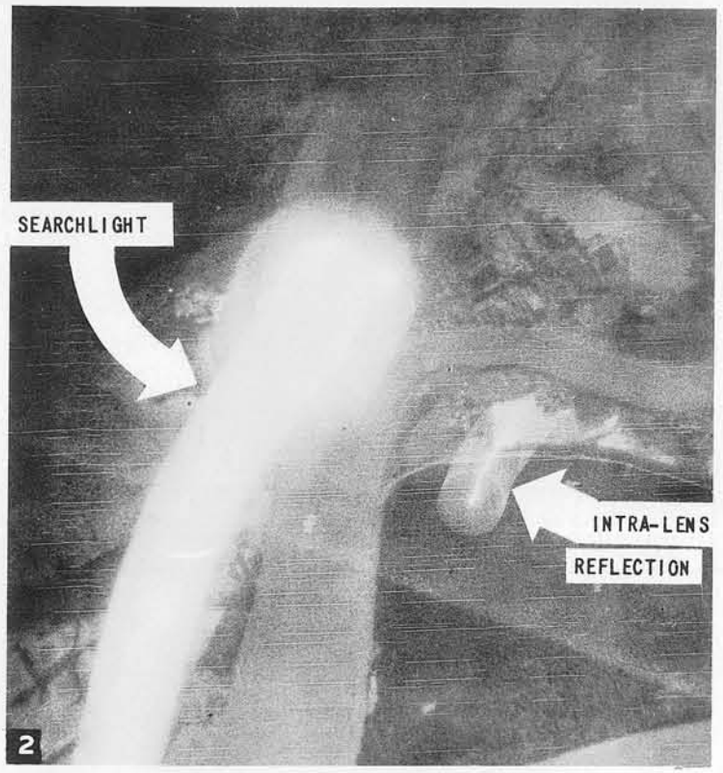
3. RANGOON, BURMA. A complete searchlight track at Malagon Yards. The ground location of the light is obtained by referring to daylight coverage (#4).

4. RANGOON, BURMA. Daylight photograph showing a searchlight and sound locator revetments at Malagon Yards.

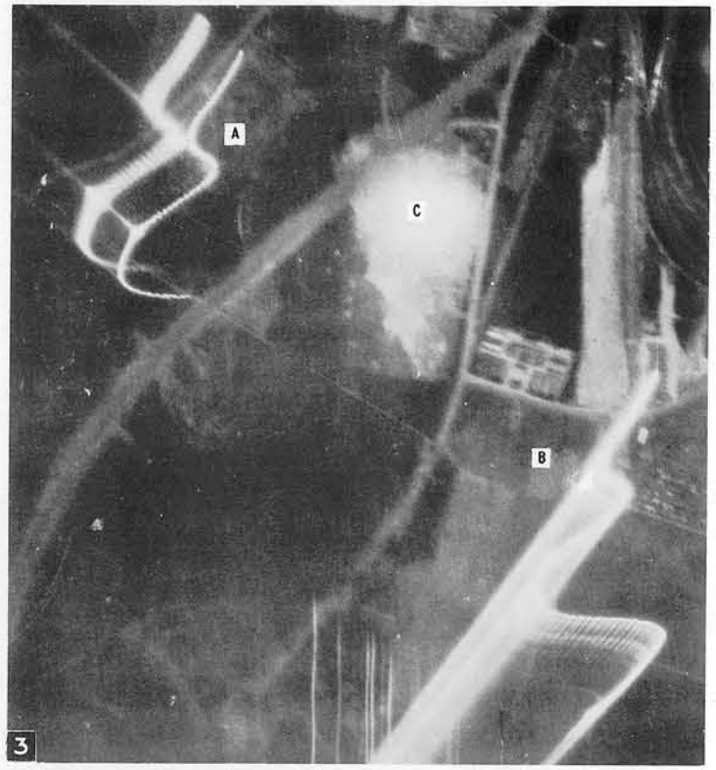
1. DUFFERIN GARDENS, RANGOON, BURMA. A searchlight track can be used to pinpoint fires when the position of the searchlight itself is known. The position of the searchlight on its track is known and is marked with a cross. The fires at the bottom right are presumed to be located at corresponding points on their tracks. Usually it is necessary for the respective tracks to be complete for this deduction to be made, but in this case, subsequent day cover proved that fires had been burning at the points indicated. Conversely, a searchlight may be located if a fire is pinpointed by a smoke plume along its track.



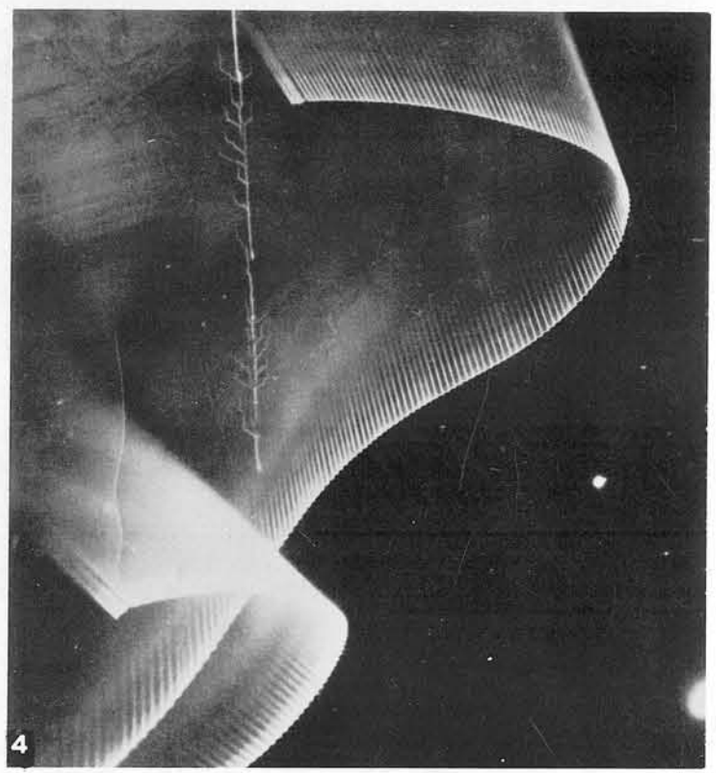
2. RANGOON, BURMA. A searchlight was focused on the aircraft at the time of photography. Sharp evasive action taken by the aircraft is indicated by the track running off the picture at right angles to the line of flight. The oblong shaped halation is caused by intralens reflection of the searchlight directed into the camera lens. No beam is visible since it has become merged with the bowl track.



3. NURNBURG, GERMANY. "A" and "B" show the curtain effect of the searchlight beam. Since the track of "A" is shorter than that of "B", searchlight "A" must not have been in operation during the total exposure time of the film. "C" is the muzzle blast of a heavy AA battery. Compare this muzzle blast to the effect of the searchlight in #2, page 8.22.



4. BERLIN, GERMANY. Two incomplete searchlight tracks. The clarity and uniform fading of the curtain indicates a uniform condition of haze on mist. Oscillation of the bowl track is due to vibration of the aircraft.



SEARCHLIGHTS

OPERATIVE CHARACTERISTICS OF SEARCHLIGHTS

The principal elements external to the searchlight which affect it's efficiency and performance are:

1. The distance from searchlight to target.
2. The absorption of the atmosphere.
3. The dimension and characteristics of the target.

1. The distance from searchlight to target.

The illumination on the target is inversely proportional to the square of the distance to the target. When a certain point in height is reached the eye no longer perceives the dimensions of the object as it sees nothing more than a luminous point.

2. The absorption of the atmosphere.

Atmospheric conditions are of primary importance in the transmission of light. As the atmosphere is clear or misty, small or large light losses are encountered in traversing the distance between searchlight and target or the distance between the target and the observer's eye.

3. Dimensions and characteristics of the target.

The visibility of the target is affected by many factors among which are:

a. The size and angular presentation of the target.
b. The reflecting or diffusing power of the target.
c. The color of the target.
d. The effect of color and illumination contrast between the target and its background.
e. The effect of relative illumination of the field of view.

3a The size and angular presentation of the target.

While the dimensions of planes have increased, bombing heights are likewise greater, the latter factor being of greater consequence. The maximum projected area of the plane in flight will occur when the plane is directly overhead in the beam; and the projected area will decrease approximately 30% when the plane is low and viewed directly ahead. Thus, as the angle is decreased from 90^{o} to 0^{o} the visible surface area is diminished 30%.

Mist is an almost impenetrable screen for a seerchlight beam, while a rain curtain can be easily penetrated. Dust also tends to reduce the amount of light transmitted. Atmospheric absorption consists fundamentally of two elements, light scattering and true absorption. Violet and blue portions of the spectrum of the beam are scattered more strongly than other colors thereby accounting for the characteristic blue tone of the searchlight beam. A considerable part of the scattered light comes back toward the searchlight and the observer. Scattered light also acts to form a screen surrounding the target. True absorption of the shorter wave length portion of the spectrum is greater than that of longer wave lengths, accounting for the variation in the color of beams when analyzed from different distances from the light source. Amber and red colors predominate at the greater distances. The total absorption of the atmosphere will vary from 5% per kilometer for very clear weather to almost total absorption in fog. When measured, the absorption is also found to vary greatly for different geographical locations, seasons of the year, and altitudes.

3b Reflecting or diffusing power of the target.

Certain objects on the target may possess parts having a brilliancy which reflect the light in the direction of the observer's eye. Polished or bright surfaces on the plane should therefore be avoided or covered.

3c Color of the target.

Light objects have a highly reflective power while dark objects are very absorbent. The use of dark or black, soft textured paint will reduce the reflective property of a plane to a small fraction of that of its normal covering.

3d Effect of color and illumination contrast between the target and its background:

The color and illumination of the target with respect to it's background gives rise to an effect of contrast which greatly influences visibility. A light target on a dark background or a dark target on a light background will be more easily distinguishable than if the tints of the two are more or less similar or the degrees of illumination are comparable.

3e The effect of relative illumination on the field of view:

For visibility of near objects, a difference of only a few percent in illumination of the object and its background is necessary while for distant objects, a contrast in brightness between them and the background must be very great. Investigations have shown that, whereas a ratio of contrast in brightness of 2:1 between the target and the background is sufficient for visibility of a bombing plane a few thousand yards from the searchlight, a ratio in excess of 10:1 will be required for a distance of 10,000 yards.

Background for the beam itself also affects the relative illumination. Maximum ranges are secured on dark black nights whereas moonlight will lower the range.

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Searchlights are used independently of flak for several purposes:

1. To indicate to night fighters the track of attacking planes.

2. To illuminate and silhouette planes so that night fighters can see them more easily.

3. To dazzle bomber crews so that they cannot see targets or fighters.

4. To hide targets by concentrating a cone of light over them.

5. To counteract the effect of parachute flares by placing a cone of light under them.

6. To act as homing lights for friendly aircraft.

A single searchlight might indicate the track of a bomber by pointing at it vertically and then moving horizontally in the direction of its course. It may also focus on a point in advance of the bombers estimated course, and perhaps wave in the direction of flight. Circles are described around the plane to indicate its presence and track and to invite other individually controlled searchlights to focus on it until it can be transferred to a cone of lights. Successive pairs of lights, directed one on each side of the plane and forming a lane, may indicate the path of the bomber. Sometimes a wall of light may be formed to silhouette the attacking plane for night fighters. The projection of light beams on a cloud below the aircraft will silhouette it to overhead fighters; a cone may be used similarly as a background.

The terms "dazzle" and "glare" are often confused with one another. Dazzle is the direct blinding effect of the powerful rays, glare is the light interposed between observer and target in such a way that the target is obscured.

The following are inferences drawn from searchlight trials and experience:

(a) Dazzle does not occur unless the aircraft is directly illuminated by one or more beams.

(b) A single beam will not produce the effect except at fairly short range.

(c) A concentration of several beams can cause acute difficulty to pilot or bombardier.

(d) Head on illumination causes far more difficulty to aircraft then does illumination from abeam or astern.

(e) Short range engagement of enemy aircraft by searchlights has apparently caused pilots to lose control and crash.

Dazzle or glare effect is most pronounced between 2000 and 4000 feet and is effective up to 15000 feet. Dazzle or glare at altitudes even exceeding 10000 feet have been known to blind pilots and to make location of target difficult and accuracy of bombing poor. Night adaption of eyes is impaired. The glare effect of a searchlight trained upon a low-flying aircraft is great and it makes low-flying attacks hazardous. Glare effect does not noticeably interfere with crews of aircraft not directly in the beam.

Dazzle effect of a searchlight beam is greater in a haze than in clear weather. The Germans use lights to sweep horizontally to dazzle crews, making it difficult to see the target.

Glare can also be very effective when there is considerable ground or industrial haze, the beam of light is projected to a low angle of elevation into the haze, producing a pool of light over the target thus making identification difficult.

Searchlights are also used as a homing device for aircraft. They may be colored and are operated to conform with prearranged signals.

German A A defenses rely mainly on unseen methods of fire control but augment their fire by visually controlled guns using searchlights only when there is little or no cloud cover. Among aircraft coned by lights for more than 20 seconds (and therefore probably engaged visually), the percentage damaged has been about twice as high as among planes illuminated for a shorter period. Evidence did not indicate that those coned for more than 20 seconds were subjected to more intense A A fire than the others. The risk of being illuminated seemed to be about the same at bombing altitudes of 6000 to 20000 feet. On one occasion when conditions were favorable for searchlights, 70 to 80 bombers over a target were effectively coned (i.e. for more than 20 seconds) at the rate of about one per minute.

Heavy A A fire in coordination with searchlight cones is extremely accurate and destructive. Once the cone centers on a plane, it ignores all other aircraft and proceeds methodically to direct the destruction of the one it has caught.

Japanese Use of The Master Light.

Several areas have reported the use of the Control or Master Searchlight System by the Japanese. The Master Searchlight is distinguishable from the group of lights, for which it acts as a guide, by the bluish tinge of its beam. When the sound or radar controlled Master Light engages the target, a concentration or cone of lights centers on the blue light and moves with it. (If the other lights in the group do not immediately expose and illuminate the plane they can often be avoided by an immediate change in course and speed). According to P.O.W. reports, the blue tinge of the Master Light is caused by a colored mirror plate attached to the searchlight lens.

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